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TWO ESSAYS IN CORPORATE FINANCE

A Dissertation

by

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ABSTRACT

In this dissertation, we answer two research question in corporate finance. In the first essay, "A New Benchmark: Relative Performance Evaluation with Total Returns", we revisit the question of relative performance evaluation (RPE) in executive compensation. While previous literature has commonly rejected the use of RPE when using equity returns as performance measure, we argue that the total return of the firm is a preferable metric in RPE regressions since the exogenous common shocks analyzed in extant theory occur at the asset level. Further, it is plausible that executives are concerned about the total value of the firm since shareholders bear most of the brunt of the agency cost of other stakeholders and executives can hold nontrivial amounts of debt–like instruments. We find strong evidence in support of RPE in the compensation of top executives. In addition, we cannot reject that the magnitude of RPE used in the average contract is optimal. Overall, this essay contributes to the ongoing debate about the efficiency of executive pay.

In the second essay, "Shareholder Bargaining Power, Debt Overhang, and Investment", we analyze how shareholder bargaining power affects the underinvestment problem caused by debt overhang. Using a dynamic model of strategic bargaining between equity and debt holders following default, we relate firm-specific characteristics, such as the shareholder and bondholder ownership concentration, to debt overhang and investment. Consistent with our predictions, we find expected liquidation values and bondholder ownership concentration enhance the underinvestment effect of debt overhang, while shareholder ownership concentration mitigates it. Our results highlight how shareholder bargaining power in default can affect the underinvestment problem caused by debt overhang.

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1. INTRODUCTION

This dissertation consists of two essays that attempt to answer two research questions in corporate finance. In Section 2, we investigate if there is evidence of benchmarking in the compensation of top executives of firms. In Section 3, which is part of a larger research effort from Alanis, Chava, and Kumar (2015), we ask if potential shareholder bargaining power can affect the underinvestment caused by debt overhang.

In the first essay, "A New Benchmark: Relative Performance Evaluation with Total Returns", we study if large publicly traded U.S. firms benchmark the annual compensation of their chief executive officers (CEOs). The longstanding hypothesis of relative performance evaluation (RPE) states that CEO compensation should exclude the firm performance driven by exogenous common shocks over which the executive has no control.

Despite the strong theoretical underpinnings of RPE, previous literature has found little empirical support for it. Contrary to extant literature, in our "pay for performance" estimates the performance part is the total return of the firm instead of just its equity return. We argue this is a sensible approach since most of the exogenous common shocks occur at the asset level. We find strong statistical support for the RPE hypothesis when using total firm return as the performance metric, suggesting that firms do filter out exogenous shocks from CEO compensation. Moreover, we cannot reject that the average firm uses RPE in optimal fashion. While this essay is not a formal test of efficiency in the executive labor market, we find support for one of the main implications of an efficient executive labor market, benchmarking in compensation.

In the second essay, “Shareholder Bargaining Power, Debt Overhang, and Investment”, we analyze how shareholder bargaining power affects the underinvestment problem caused by debt overhang. Intuitively, the underinvestment problem due to risky debt is caused by the truncation of equity holders’ investment horizon at default, so that shareholders do not fully recognize the returns to investment that outstanding bondholders receive in default. However, if shareholders are able to recover some of the firm value after default, a common observed fact in U.S. bankruptcies, then the debt overhang problem may be mitigated.

We build a dynamic model of strategic bargaining between equity and debt holders following default and we relate firm-specific characteristics, such as the shareholder and bondholder ownership concentration, to debt overhang and investment. Our theoretical model generates several empirical predictions, mainly that measures generally associated with weak shareholder recovery in default (what we term weak shareholder bargaining power), such as high expected liquidation value or high bondholder concentration, should enhance the underinvestment effect of debt overhang; while proxies of high shareholder power, such as institutional ownership in the shareholder base, should mitigate the underinvestment. We find broad empirical support in the data for our theoretical predictions. This essay highlights how shareholder bargaining power in default can affect the investment choices of firms, and contributes to the ongoing debate about the effects that the structure of bankruptcy proceedings can have over a firm outside of default.

2. A NEW BENCHMARK: RELATIVE PERFORMANCE EVALUATION WITH TOTAL RETURNS

2.1 Introduction to Section 2

One of the main results from agency theory is that compensation of chief executive officers (CEOs) should be linked to firm performance to motivate effort and maximize firm value. Moreover, the hypothesis of relative performance evaluation (RPE) states that the compensation should exclude the firm performance driven by exogenous common shocks over which the executive has no control. Theoretical arguments show that the use of RPE leads to more efficient contracts because it allows the firm to contract over a more precise measure of the agent's effort and, at the same time, it lowers the risk faced by the CEO in her compensation (see Holmström, 1982; Holmström and Milgrom, 1987; Pendergast, 1999).

Despite the strong theoretical underpinnings of RPE, prior empirical research has found little support for it. Abowd and Kaplan (1999) call the weak empirical evidence in favor of RPE an important puzzle for executive compensation. In this essay we revisit the question of RPE in CEO compensation under a different metric of firm performance.

Previous literature on RPE has almost exclusively employed stock returns as the measure of firm performance and the average return of the industry as instrument for the exogenous common shock (see the survey of evidence in Murphy, 1999; Abowd and Kaplan, 1999). We argue that the total return of the firm –or the return on the firm's assets– is a better choice to identify the common shock.

Extant theory in RPE assumes that the exogenous shock affects the firm (or project) at the operating cash flow level (Holmström, 1982; Holmström and Milgrom, 1987). Stock returns, on the other hand, represent levered cash flows. Thus, if a common shock is experienced at the operating level (for instance a shock to sales or cost), the stock price reaction to this shock will be affected by the leverage of the firm. Moreover, Garlappi and Yan (2011) show that the effect of leverage on equity risk may be nonlinear and could even have different signs depending on the default risk of the firm. In addition, the stock price reaction to a common shock may also reflect changes to agency costs, expected distress costs, and financial constraints, which may also vary with a firm's capital structure.[1]

We argue that total firm return –which includes equity returns but also the return on the firm's debt– is a better measure of performance in RPE regressions. The total return provides a better representation of the asset performance of the firm, where the common shock is assumed to occur. We find strong statistical support for the RPE hypothesis when using total firm return as the performance metric, suggesting that firms do filter out exogenous shocks from CEO compensation.

Prior literature has commonly gaged firm performance by its equity return since the fiduciary duty of a CEO is to her shareholders and, in addition, the average CEO holds substantial equity–like instruments in her own firm (Murphy, 1999). However, the agency cost literature suggest that shareholders ultimately bear the agency costs suffered by other stakeholders (Jensen and Meckling, 1976). Based on this agency cost argument, Edmans and Liu (2011) note that it appears intuitive that companies should pay managers according to firm value, rather than equity value alone. In the same vein, Dewatripont and Tirole (1994) ask "why does compensation design meant to maximize total firm value have managers paid in stocks rather than as a function of total firm value, even when well–functioning debt markets exist?" [p.1027].

[1] Bernanke and Gertler (1989) demonstrate that business cycle shocks can enhance or mitigate agency costs, while Gertler and Gilchrist (1994) show that less financially constrained firms are better able to respond to external shocks.

Further, Sundaram and Yermack (2007) show that executives are not compensated exclusively with cash and equity–like instruments, but rather they hold non-trivial amounts of inside debt.[2] Thus, it also seems plausible that executives with large inside debt stakes will care not only about the equity return of their firm but rather about its total return.

In this essay we obtain an estimate of the total return of a firm in two ways. First, we calibrate the structural model of firm value from Merton (1974) to obtain an estimate of the total firm return. This model from Merton (1974) has been used extensively in the credit risk literature to obtain default probability estimates (see Vassalou and Xing, 2004; Bharath and Shumway, 2008; Chava and Purnanandam, 2010). We use the calibration procedure of Vassalou and Xing (2004) in order to back out of the model the annualized total return on the firm's assets.

A second way we obtain the total return on the firm is by using actual bond prices from the Trade Reporting and Compliance Engine (TRACE) database. For a small sample of firms we are able to obtain market returns on their publicly traded corporate bonds, and by assuming that the firm's debt return is the same as its return on public bonds, we obtain an estimate of total firm return based on market prices.

Once we have an estimate of total returns, we follow previous literature and use a firm's industry affiliation as its peer group exposed to the same common shocks (see Antle and Smith, 1986; Gibbons and Murphy, 1990; Janakiraman, Lambert, and Larcker, 1992; Aggarwal and Samwick, 1999a). The average performance of this peer group (we exclude the own firm in this average) represents the common exogenous shocks suffered by the industry. The average total return of the industry is closer to

[2]Edmans and Liu (2011) define inside debt as pensions and any type of deferred compensation in which the executive has equal priority with other creditors in the event of bankruptcy.

the exogenous shocks analyzed in the theoretical literature of RPE since it represents the return on the operating assets.

We obtain CEO compensation data from 1992 to 2012 from Execucomp and estimate the sensitivity of the annual compensation flow to firm and industry total return, controlling for firm and CEO characteristics plus year and executive dummies. As expected, we find that compensation is positively related to the firm's total return, but importantly, we find that compensation is negatively related to the industry total return. This is exactly what the RPE theory states, the common shock in the firm's performance is filtered out of compensation. Our findings are robust to using total returns from the calibrated Merton (1974) model or the ones obtained with actual bond prices, despite the different sample size.

Moreover, we test if the amount of filtering is optimal. Under some distributional assumptions, Holmström and Milgrom (1987) and Banker and Datar (1989) derive the optimal ratio of industry to firm performance sensitivity that should exist in an efficient contract under RPE. Intuitively, the more correlated that the firm and industry performance are, the more filtering should occur in compensation.

We test for this optimal use of RPE in our regressions and we cannot reject the null hypothesis that firms are using RPE in optimal fashion in CEO compensation.[3] We believe this represents an important result since, to our knowledge, we are the first study to show evidence in support of optimal use of RPE in the compensation of CEOs.

We show that our main findings are robust to several potential issues. We obtain qualitatively similar results when we estimate firm–specific regressions which allow pay sensitivities to differ across firms in our sample. Our results continue to hold for

[3]This test is also as the strong–form test of RPE (Antle and Smith, 1986). It is mostly absent from the empirical literature since most studies fail to find that even some filtering is occurring.

the most part when we consider different industry definitions used in the literature, or when we use different weighting schemes to construct industry performance. As well, we find suggestive (though not statistically significant) evidence of RPE when we use a small sample of executive compensation data from 1963 to 1991.[4] Further, we show our results are robust to the enactment of accounting rule FAS 123R in 2006 which changed the way firms expense equity–like awards and increased disclosure requirements on compensation.

We also investigate the robustness of our results in two settings that challenge the use of RPE. A key condition of RPE is that the agent cannot influence the output of her peer group, which is likely violated in less competitive industries where firms respond to strategic actions taken by their peers. As in Aggarwal and Samwick (1999b) we use the Herfindahl index of market share as a measure of industry competition and we find some weak evidence that less competitive industries use lower amounts of RPE in CEO compensation, though the regression estimates are only marginally statistically significant.

In addition, we test if industries with high strategic flexibility make less use of RPE. Galopan, Milbourn, and Song (2010) argue that in these type of industries CEOs can choose the level of exposure of their firm to the common shock even in the short run, violating again a key assumption of RPE. When we restrict our tests to industries with high strategic flexibility –high market to book ratio and high R&D spending– our main findings remain qualitatively unchanged, as we do not find evidence of less use of RPE in these setting.

Overall, our paper contributes to the recent discussion about the efficiency of CEO contracting. Bertrand and Mullainathan (2001), Bebchuk and Fried (2004),

[4]This dataset is a subset of the one used by Frydman and Saks (2010), who hand collect it to show that some of the stylized facts observed in compensation since the 1980s may not be present in earlier decades.

and Garvey and Milbourn (2006) suggest that executives enjoy some level of capture over the compensation process, while Gabaix and Landier (2008) show that the rise of executive compensation can be explained within a framework of competitive markets and rare skills. Our contribution is to show that one of the main implications of the principal–agent model, that of relative performance evaluation, seems to be supported by the data. This finding is in line with the view that, in this respect, pay in the CEO labor market is set competitively.

The rest of the paper is organized as follows. Section 2.2 presents the empirical methodology and data used in our analysis, including a detailed description of how we compute total firm returns. Section 2.3 contains our main findings, while section 2.4 investigates the robustness of these findings to several potential issues. The final section provides some concluding remarks.

2.2 Methodology

Baker and Hall (2004) argue that the correct empirical specification relating compensation to firm performance depends on what drives CEO incentives, whether it is dollar or fractional ownership in the firm.

Previous literature measures firm performance in two different ways, as the annual percentage return or as the annual change in total shareholder wealth (the stock return multiplied by the start of period market capitalization). Hall and Liebman (1998) and Baker and Hall (2004) argue that if CEO incentives increase with CEO dollar ownership, then percentage returns are the correct performance metric. If, instead, CEO incentives are driven by the executive's fractional ownership, then performance should be specified in dollar terms.

Murphy (1999) shows that regressing levels of compensation against stock returns is the correct specification when CEO incentives respond to dollar ownership; on the other hand, if CEO incentives are driven by fractional ownership, the correct empirical model is to regress changes in compensation to stock returns.

We make no claim as to the correct measure of performance and instead use both specifications. When the driver of CEO incentives are her dollar amount stake in the company, the correct regression specification is in levels of compensation,

$$\begin{aligned} Log(Pay)_{it} = \eta_t + \delta_i + \alpha_1 Firm\ Performance_{it} + \alpha_2 Industry\ Performance_{it} \\ + \beta_1 Firm\ Controls_{it-1} + \beta_2 CEO\ Controls_{it} + \varepsilon_{it} \end{aligned} \tag{2.1}$$

When the driver of CEO incentives are her fractional ownership of the company, the correct regression specification is in changes of compensation,

$$\begin{aligned} \Delta Log(Pay)_{it} = \eta_t + \delta_i + \alpha_1 Firm\ Performance_{it} + \alpha_2 Industry\ Performance_{it} \\ + \beta_1 \Delta Firm\ Controls_{it-1} + \beta_2 CEO\ Controls_{it} + \xi_{it} \end{aligned} \tag{2.2}$$

The intuition behind these regressions is that CEO pay should be related to the idiosyncratic part of *Firm Performance* but the common shocks –over which the agent has no control– should be filtered out of the compensation flow. The *Industry Performance* measure reflects the common shocks to the industry plus additional noise, thus this second term serves to filter out the common shocks from the compensation package.

We conduct two tests of RPE: a weak–form version that tests if at least some of the common shock is filtered out of compensation, and the strong–form test that examines if the level of RPE in the contract is optimal.

The weak–form version of RPE tests the null hypothesis $\text{H}_0 : \alpha_2 \geq 0$ against the alternative $\mathrm{H}_A : \alpha_2 < 0$. This is known as the weak–form because rejection of the null implies that some of the common shocks affecting performance are removed from CEO compensation, but it may or may not be the optimal amount.

Under certain distributional assumptions[5], Holmström and Milgrom (1987) and Banker and Datar (1989) show that there exists an optimal level of RPE which trades off incentives, risk–sharing, and the information of common shocks contained in the industry performance measure. This test is known as the strong–form version of RPE, where the null hypothesis is $\mathrm{H}_0 : \alpha_2/\alpha_1 = -\frac{\mathrm{cov}(Firm\ Performance, Industry\ Performance)}{\mathrm{var}(Industry\ Performance)}$ and the alternative one is $\mathrm{H}_A : \alpha_2/\alpha_1 \neq -\frac{\mathrm{cov}(Firm\ Performance, Industry\ Performance)}{\mathrm{var}(Industry\ Performance)}$. This test is well defined only if α_1 is different from zero, otherwise the ratio of pay sensitivities of industry and firm performance is not defined.

If the test fails to reject the null, it provides evidence, under the model of Holmström and Milgrom (1987), that the common shock in performance is completely removed and the CEO is evaluated solely on the basis of her idiosyncratic performance.

We include year fixed effects in equations (2.1) and (2.2) to account for potential time trends in compensation. Following Graham, Li, and Qiu (2011) we also include executive fixed effects to control for potentially unobserved CEO characteristics such as managerial style and risk preferences. As Albuquerque (2009), we control for firm size by the *Log of assets* and *Log of sales*, we also include the *Market to book ratio* of assets to control for growth opportunities, we use book *Leverage* and the annualized standard deviation of daily stock returns (*Stock volatility*) to account for firm risk, we control for profitability with the *Return on assets*, and for *Institutional ownership* with the percent of shares outstanding held by the top five institutional investors.

[5]These are the assumptions behind the LEN model: linear sharing rule, exponential utility, and normal distributed errors.

We control for executive characteristics with *CEO tenure* in years, the *Log of CEO age* –if missing we set it at zero and include a dummy for missing values–, we also include a *CEO chair dummy* equal to one if the CEO serves also as the chairman of the board of directors, and *Interlock dummy* equal to one if the CEO has an interlock relationship with a board member, and a *CEO ownership dummy* if the executive holds more than 5% of outstanding shares in the company (changing the cutoff value to 2% or 7.5% does not affect out results).

2.2.1 Data sources

We obtain data on CEO compensation from Execucomp for years 1992 to 2012. We merge compensation data with accounting information from Compustat and stock price information from CRSP. We require firms to have positive total assets and sales, as well as nonmissing stock return information. Further, we exclude observations for which there are more than one CEO or the executive was in the firm for less than a year, and also when the CEO owns more than 30% of all outstanding shares in the company.[6] We deflate all dollar values with the Consumer Price Index obtained from the Federal Reserve's FRED database.

For ease of comparison with previous literature we classify a firm's industry affiliation by the first two digits of its Standard Industry Classification (SIC) system. In robustness tests we also use the Fama–French 49 industries, the three digit North American Industry Classification System (NAICS), the six digit Global Industry Classification System (GICS), and the 100 fixed industry classification from Hoberg and Phillips (2010).

We screen regulated utilities (SIC between 4900 and 4949) and public administra-

[6] Results are unaffected by changing the cutoff value to 25% or 50% of all outstanding shares.

tion and government entities (SIC above 9000) since compensation and performance in these type of firms may suffer from different regulations and oversight.

We measure annual total compensation with Execucomp item *tdc1*. Starting with 2006 accounting rule FAS 123R modified the way option compensation is reported, thus to obtain a consistent time series we adjust for the reporting change following Kini and Williams (2011) and Coles, Daniel, and Naveen (2014). In robustness tests, we cutoff the sample in 2005 to avoid the impact of FAS 123R and find qualitatively similar results. Since annual compensation is highly skewed we take the log value.

As Albuquerque (2009), we do not include changes in the value of existing firm options and stock holdings owned by the CEO. The revaluation of these previously granted securities is mechanically related to the firm's performance and thus independent of relative output (see Gibbons and Murphy, 1990; Hall and Liebman, 1998; Aggarwal and Samwick, 1999a). The annual compensation flow will understate the true incentives faced by the CEO, since the latter include all CEO wealth that fluctuates with firm output.

We use two performace metrics: equity return and total firm return. We measure the annual equity return of a firm as the monthly compounded stock return including dividends. Total firm return is the market return on the firm's assets, we obtain this measure from a calibrated Merton (1974) model and also by combining equity returns with observed corporate bond returns from TRACE. In the following subsection we explain in detail the procedure to obtain total firm returns.

For each firm we compute industry performance as the market capitalization weighted average of all other firms with the same two digit SIC industry classification excluding the firm. We require at least other three firms in the same industry to compute peer performance for a firm–year.

2.2.2 Total firm return

The total annual return of the firm is the weighted sum of the equity return plus its debt return where the weight is the firm's debt to market equity ratio. Unfortunately, market values of total debt are not readily observable for most firms. Hence, we estimate total firm return in two different ways.

First, we calibrate the credit risk model of Merton (1974) following Vassalou and Xing (2004) and Bharath and Shumway (2008). Merton (1974) views the value of equity in a firm as a call option on the firm's assets, where the strike price of the option is the firm's debt. This model has been used extensively in the default risk literature (see Vassalou and Xing, 2004; Bharath and Shumway, 2008; Chava and Purnanandam, 2010).

Given the assumption that firm value follows a geometric Brownian motion, Vassalou and Xing (2004) use an iterative procedure to calibrate the model. We follow the same iterative algorithm to back out the market value of the firm's assets and their annual return.

Using the calibrated Merton (1974) model to back out firm value has the benefit that it is possible to obtain for a broad sample of firms with a long time series. However, the cost of this method is that it does not represent true market information and the results may be overly sensitive to the calibration parameters. As an alternative, we obtain bond transaction data from TRACE and compute bond returns from actual market prices.

Starting in 2002 TRACE collects individual bond transaction information and beginning in 2005 coverage is considered virtually all publicly traded bonds in the U.S. (see Bessembinder, Kahle, Maxwell, and Xu, 2009). We merge price data from TRACE with bond information from Mergent's FISD to obtain a comprehensive database of all bond transactions of U.S. corporate bonds from 2002 to 2012.

We keep all non–asset backed, nonconvertible, nonputable bonds with fixed coupon rate. Since most bonds do not trade on a daily basis, to compute the annual return over the fiscal year we choose the transactions closest to the start and end of the fiscal year around a 30 day window and compute the bond return as the change in clean price plus the accrued interest payments.[7] For firms with multiple bonds we compute the weighted average return where the weight is the market value of the bond at the start of the year.

Since we obtain data only for corporate public bonds, we assume that the debt return of a firm is the same as the bond return obtained from TRACE. Finally, we estimate the total firm return as the weighted average of the equity and debt return where the weights are the market value of equity and book value of debt, respectively.

This second alternative has the benefit of providing a true market return for a component of the firm's debt. The downside of using bond prices is a much smaller sample with a shorter time series, and we must assume that all of the firm's debt has the same return as its public bonds.

2.2.3 Descriptive statistics

The final sample consists of 24,207 firm–year observations for 2,525 unique firms and 4,774 different CEOs. Table 2.1 presents summary statistics for the main variables used in the paper. All dollar values are deflated by the Consumer Price Index.

The median CEO in our sample receives annual real flow compensation of $1.27 million, we can observe that compensation is very skewed, with the median being roughly half of the mean. For this reason we use the log of compensation as dependent

[7] Choosing instead a 15 or 10 day window does not alter the results.

variables in our regressions. In over half of all observations the CEO is also the chairman of the board of directors and has been the company's top executive for about 5.5 years. In 13% of our firm–years the CEO holds over 5% of the outstanding shares of the firm, which suggests the possibility of entrenchment.

The median firm in our sample is medium to large with sales of over half a billion in real dollars and moderately levered at 20%. Most firm–years in our sample are generating profits with positive return on assets even at the first quartile of the distribution. The median stock return is 8.4% while the median total return is slightly lower at 5.6%, this is natural since shareholders have a levered position on the firm's assets. Overall, our sample looks similar to that of previous studies of RPE on executive compensation such as Albuquerque (2009) and Galopan, Milbourn, and Song (2010).

Table 2.2 presents Pearson correlations between our measures of compensation and performance. The level of compensation has a very small positive correlation with firm performance measures and a slightly negative one with industry performance. The change in compensation has stronger positive correlations with firm returns but also industry performance.

The correlation between firm equity return and firm total return is very high (0.81), which is to be expected since the difference between these two is the return on debt, and as seen on Table 2.1 the leverage ratio is moderate for the average firm in the sample. We can also note that the correlation between firm and industry performance is roughly the same for equity and total firm returns.

Table 2.1: Summary statistics

This table presents descriptive statistics for variables used in this study. The sample comprises the intersection of Execucomp, Compustat, and CRSP for all CEOs with available data from 1992 to 2012. *Firm Equity Return* is the real annual stock return assuming monthly dividends are reinvested in the company. *Firm Total Return* is the real annual change in firm value extracted from the Merton (1974) model. The *Market to book ratio* is the sum of market value of equity plus the book value of debt divided by total book assets. *Return on assets* is the ratio of net income to the start–of–the–year book assets. *Leverage* is the ratio of the book value of debt to the book value of assets. *Institutional ownership* is the percent of shares outstanding held by the top five institutional investors at the start of the year. *Stock Volatility* is the annualized standard deviation of daily returns during the fiscal year. *Annual compensation* is the sum of salary, bonus, restricted stock grants, the Black–Scholes value of options granted, and all other compensation for the CEO during the year. *Tenure* is the number of years the executive has remained as CEO in the company. *Age* is the age in years of the executive. *CEO chair dummy* is an indicator variable equal to one if the CEO is also the chairman of the board. *Interlock dummy* is an indicator variable equal to one if the CEO is involved in an interlock relationship with a member of the board of directors as defined by Execucomp. *CEO ownership dummy* is an indicator variable if the CEO owns over 5% of outstanding shares of the firm. All accounting variables are winsorized at the 1st and 99th percentile. All dollar figures are deflated by the Consumer Price Index.

	Median	Mean	Std. Dev.	25^{th}	75^{th}	Observations
Firm Characteristics						
Firm Equity Return (%)	8.35	18.71	71.44	-14.93	34.95	24,207
Firm Total Return (%)	5.64	7.23	39.02	-14.52	26.53	24,207
Sales ($ billions)	0.56	2.57	8.37	0.20	1.77	24,207
Market to book ratio	1.60	2.11	1.96	1.21	2.36	24,207
Return on Assets (%)	5.94	5.57	10.44	2.06	10.44	24,207
Leverage	0.20	0.21	0.18	0.05	0.33	24,207
Institutional ownership (%)	26.28	26.71	9.72	20.15	32.68	24,207
Stock Volatility	0.40	0.45	0.22	0.30	0.54	24,207
CEO Characteristics						
Annual compensation ($ millions)	1.27	2.39	5.34	0.63	2.67	24,207
Tenure (years)	5.50	7.56	7.61	2.58	10.25	24,207
Age (years)	55.00	55.30	7.45	50.00	60.00	22,039
CEO chair dummy	1.00	0.56	0.50	0.00	1.00	24,207
Interlock dummy	0.00	0.05	0.22	0.00	0.00	24,207
CEO ownership dummy	0.00	0.13	0.33	0.00	0.00	24,207

Table 2.2: Correlation matrix

This table presents the Pearson product–moment correlations between annual CEO compensation flow and firm performance. For each firm, industry performance is the market capitalization–weighted average of performance of all other available firms with the same 2 digit SIC industry classification. The sample is for 1992 to 2012.

	Log(Pay)	ΔLog(Pay)	Firm Equity Return	Firm Total Return	Industry Equity Return	Industry Total Return
Log(Pay)	1.00					
ΔLog(Pay)	0.33	1.00				
Firm Equity Return	0.02	0.16	1.00			
Firm Total Return	0.02	0.18	0.81	1.00		
Industry Equity Return	-0.02	0.05	0.33	0.37	1.00	
Industry Total Return	-0.02	0.03	0.27	0.35	0.74	1.00

2.3 Results

We first test for RPE in the levels of CEO compensation. This is the correct empirical specification if incentives are driven by dollar ownership. Table 2.3 presents the estimation results from equation (2.1) when we classify peer groups by the firm's two digit SIC industry classification. The industry return variable represents shocks common to all firms in the same industry, thus a negative coefficient on this variable suggests that firms filter out part of these shocks from the compensation contract of CEOs.

In model 1 we test for RPE using equity returns. Results are consistent with previous literature where we observe a positive and statistically significant association between the firm's equity return and CEO annual compensation, but a statistically insignificant association between industry return and compensation.

In model 2 we use the firm's total return, obtained from the calibrated Merton (1974) model, as the performance metric. We observe that the firm's total return is positive and statistically significant while the industry total return is negative and statistically significant at the 1% level, which is consistent with weak–form RPE.

As suggested by Graham, Li, and Qiu (2011), models 1 and 2 include executive dummies to control for potential time–invariant unobserved characteristics. In model 3 we include firm dummies instead, to control for potential invariant omitted variables at the firm level, results are mostly unaffected as we still observe a positive impact from the firm's total return and a negative coefficient for the industry total return.

In model 4 we perform an additional check to our specification. We argue that the industry total return presents a better measure of the exogenous common shock to the industry, and, based on RPE, this shock should not factor in CEO compensation. In models 2 and 3, the impact of the industry total return on compensation is negative because the firm total return already includes the common shock and is positively associated to compensation.

In model 4, we estimate our regression including only the industry total return; since we exclude the firm return, we expect the common shock to have no effect on compensation. This is indeed what we observe. The point estimate of the industry total return is very small and not statistically significant, suggesting that the exogenous common shock to the industry is not associated with compensation.[8]

In panel B of Table 2.3 we if the level of RPE observed in the regression is consistent with the optimal level of RPE suggested by Holmström and Milgrom (1987). As mentioned above, finding that part of the common shocks are filtered out of compensation is not sufficient evidence that firms make optimal use of relative performance. Holmström and Milgrom (1987) show that the optimal level of RPE is when $\alpha_2/\alpha_1 = -\frac{\mathrm{cov}(Firm\ Performance, Industry\ Performance)}{\mathrm{var}(Industry\ Performance)}$, this test is also known as the strong form version of RPE (see Antle and Smith, 1986).

In panel B we present the results from a Wald test where the null hypothesis is that of the optimal use of RPE. For model 1 the test is not informative since, as shown above, for equity returns there is no RPE even in weak form. When we use total returns as the performance metric in models 2 and 3 we observe that the Wald test fails to reject the optimal level of RPE even at the 10% significance level. This finding suggests that firms not only filter some of the common shocks out of compensation, but that they filter these shocks in an optimal way.

We next test for RPE using changes in the annual compensation; this is the correct empirical specification when the CEO's incentives for effort are driven by her

[8] It is important to be careful when interpreting results from this regression since, by excluding the firm return, we have created an omitted variable bias in the specification. Given the positive correlation between the firm and industry total return observed in Table 2.2 and the positive coefficient of the firm return in models 2 and 3, the point estimate for the industry return is biased upward. We view the evidence of this regression as merely suggestive.

Table 2.3: RPE in the level of compensation flow

This table estimates the equation $\log(Pay_{it}) = \delta_t + \eta_j + \alpha_1 x_{it}^{firm} + \alpha_2 x_{it}^{industry} + \beta' ControlVariables_{it} + \xi_{it}$ where x^{firm} ($x^{industry}$) is a measure of firm (industry) performance. For model 1, the measure of performance is the annual equity return, for models 2, 3, and 4 it is the annual total return. For each firm, industry performance is the market capitalization–weighted average performance of all other available firms with the same 2 digit SIC industry classification. Panel B presents a Wald test for the strong form version of RPE where the null hypothesis is $H_0 : \alpha_2/\alpha_1 = -cov(x^{firm}, x^{industry})/var(x^{industry})$. The sample spans from 1992 to 2012. Variable definitions are presented in Table 2.1. Heteroskedasticity robust t–statistics clustered at the firm level are in parentheses. The superscripts ***, **, and *, indicate significance at the 1%, 5%, and 10% level, respectively.

	Model 1		Model 2		Model 3		Model 4	
	Estimate	t-value	Estimate	t-value	Estimate	t-value	Estimate	t-value
Firm Equity Return	0.086***	(4.87)						
Industry Equity Return	-0.024	(-1.13)						
Firm Total Return			0.208***	(6.61)	0.222***	(6.95)		
Industry Total Return			-0.140***	(-3.19)	-0.128***	(-2.87)	-0.013	(-0.32)
Log of assets	0.251***	(6.55)	0.267***	(6.73)	0.290***	(6.71)	0.222***	(6.04)
Log of sales	0.068*	(1.93)	0.074**	(2.14)	0.071*	(1.76)	0.070**	(1.99)
Market to book ratio	0.034	(1.61)	0.036*	(1.68)	0.038**	(2.12)	0.025	(1.38)
Leverage	-0.367***	(-4.72)	-0.394***	(-5.13)	-0.419***	(-5.67)	-0.317***	(-4.04)
Return on Assets	1.095***	(7.53)	1.020***	(7.09)	1.061***	(7.21)	1.249***	(8.63)
Institutional ownership	-0.061	(-0.63)	-0.074	(-0.78)	-0.114	(-1.11)	-0.063	(-0.65)
Stock Volatility	-0.013	(-0.22)	0.039	(0.72)	0.024	(0.47)	0.047	(0.87)
CEO ownership dummy	-0.088	(-1.46)	-0.083	(-1.38)	-0.279***	(-4.84)	-0.090	(-1.49)
CEO chair dummy	0.025	(0.98)	0.025	(0.98)	0.059**	(2.23)	0.025	(0.96)
CEO tenure	-0.004	(-0.22)	-0.001	(-0.05)	0.006	(0.45)	-0.006	(-0.38)
Log of CEO age	-0.174	(-1.10)	-0.191	(-1.21)	-0.148	(-1.23)	-0.179	(-1.12)
Missing Age dummy	-0.773	(-1.21)	-0.841	(-1.32)	-0.644	(-1.34)	-0.797	(-1.24)
Interlock dummy	0.082	(0.94)	0.082	(0.95)	0.024	(0.47)	0.080	(0.93)
Year dummies	Yes		Yes		Yes		Yes	
CEO dummies	Yes		Yes		No		Yes	
Firm dummies	No		No		Yes		No	
R^2	0.35		0.36		0.37		0.34	
Observations	24,207		24,207		24,207		24,207	
Panel B: Strong Form RPE Test								
F statistic	4.14		0.37		1.48			
p–value	0.04		0.54		0.22			

fractional ownership in the firm.

Table 2.4 presents regression estimates of equation (2.2) when, again, a firm's peer group is defined by all other firms in the same two digit SIC industry. Results are broadly consistent with Table 2.3. In model 1 we observe that changes in CEO compensation are positively associated with her firm's equity return, but the impact of the industry equity return is not statistically significant.

Model 2 uses instead the total firm return and we find evidence in support of RPE; the point estimate on the industry total return is negatively and statistically significant at the 1% level. Point estimates are in line with previous studies of the impact of performance on pay. Murphy (1999) finds that the pay–performance semi–elasticity using equity returns vary between 0.09 and 0.26, which is similar to our estimated magnitudes.

In model 4 we again estimate our regression excluding the firm total return, so as to estimate the standalone impact of the common shock. We again stress that the results from this regression are merely suggestive since it suffers from an omitted variable bias by not including the firm return in the specification. As in Table 2.3, we observe that the point estimate of the industry total return is very small and statistically insignificant, suggesting that the common industry shock by itself is not affecting compensation.

In panel B we present results for a Wald test of the null hypothesis that the amount of RPE is optimal in the sense of Holmström and Milgrom (1987). For model 1, which uses equity returns as the performance metric, the test is uninformative since the regression estimates suggest there is no RPE in this case. For models 2 and 3, which use total return as the performance metric, we find support for the strong form version of RPE. In model 2, which contains CEO dummies, we fail to reject the null of optimal use of RPE at the 10% level, while in model 3, which uses firm dummies, we fail to reject the null at a 5% confidence level.

Overall, we find strong statistical evidence in favor of RPE in both empirical specifications. Further, for both specifications we cannot reject that the level of RPE is optimal in the sense of Holmström and Milgrom (1987).

2.3.1 Firm return from observed bond prices

In the previous section our estimates of total returns are obtained from calibrating the Merton (1974) model. This method makes it possible to obtain total returns for large sample of firms; however, this does not represent true market information and it is possible results could be overly sensitive to the calibration procedure. In this section we check the robustness of our results by using market prices for a firm's debt to obtain an estimate of total return.

As explained in section 2.2.2, we use bond prices from TRACE to construct an estimate of a firm's total return which is based on observed market prices of equity and debt. Unfortunately, using bond prices from TRACE reduces drastically our sample. We are able to use observations from 2002 onward and only for firms with traded corporate bonds in TRACE.[9] In this case, our sample consists of 4,010 firm–year observations for 950 unique firms and 1,297 distinct executives.

Table 2.5 presents regression results with this alternate estimation of total returns. In model 1 we use the empirical specification with the level of annual compensation while in model 2 we use the change in compensation. Unsurprisingly, for both specifications we find a positive and statistically strong association between the firm's total return and the annual CEO compensation. More importantly, despite the small sample size we find evidence in support of RPE. For the specification in levels, the

[9] We also keep all firm–years with no debt in their capital structure since in this case the equity return is the total return.

Table 2.4: RPE in the change of compensation flow

This table estimates the equation $\Delta \log(Pay_{it}) = \delta_t + \eta_j + \alpha_1 x_{it}^{firm} + \alpha_2 x_{it}^{industry} + \beta' ControlVariables_{it} + \xi_{it}$ where x^{firm} ($x^{industry}$) is a measure of firm (industry) performance. For model 1, the measure of performance is the annual equity return, for models 2, 3, and 4 it is the annual total return. For each firm, industry performance is the market capitalization–weighted average performance of all other available firms with the same 2 digit SIC industry classification. Panel B presents a Wald test for the strong form version of RPE where the null hypothesis is $H_0 : \alpha_2/\alpha_1 = -cov(x^{firm}, x^{industry})/var(x^{industry})$. The sample spans from 1992 to 2012. Variable definitions are presented in Table 2.1. Heteroskedasticity robust t–statistics clustered at the firm level are in parentheses. The superscripts ***, **, and *, indicate significance at the 1%, 5%, and 10% level, respectively.

	Model 1		Model 2		Model 3		Model 4	
	Estimate	t-value	Estimate	t-value	Estimate	t-value	Estimate	t-value
Firm Equity Return	0.191***	(7.99)						
Industry Equity Return	-0.049	(-1.35)						
Firm Total Return			0.358***	(11.31)	0.370***	(13.35)		
Industry Total Return			-0.202***	(-3.04)	-0.198***	(-3.49)	0.013	(0.21)
Δ Log of assets	0.069	(1.10)	0.068	(1.10)	0.095*	(1.71)	0.037	(0.57)
Δ Log of sales	-0.137**	(-2.35)	-0.130**	(-2.25)	-0.100*	(-1.82)	-0.134**	(-2.30)
Δ Market to book ratio	0.021**	(2.04)	0.022**	(2.01)	0.020**	(2.05)	0.017*	(1.77)
Δ Leverage	-0.247*	(-1.78)	-0.238*	(-1.72)	-0.259**	(-2.13)	-0.228	(-1.61)
Δ Return on assets	0.502***	(3.78)	0.440***	(3.33)	0.414***	(3.47)	0.796***	(6.21)
Δ Institutional ownership	-0.160	(-1.17)	-0.185	(-1.35)	-0.149	(-1.20)	-0.170	(-1.24)
Δ Stock Volatility	0.031	(0.50)	0.075	(1.23)	0.091*	(1.69)	-0.014	(-0.23)
CEO ownership dummy	0.041	(0.62)	0.048	(0.71)	0.018	(0.50)	0.058	(0.85)
CEO chair dummy	-0.028	(-1.01)	-0.023	(-0.84)	-0.029*	(-1.71)	-0.031	(-1.07)
CEO tenure	0.079***	(2.96)	0.080***	(3.00)	0.035***	(3.16)	0.082***	(3.06)
Log of CEO age	0.324	(1.01)	0.318	(0.99)	-0.171***	(-2.65)	0.367	(1.13)
Missing Age dummy	1.268	(0.97)	1.254	(0.96)	-0.707***	(-2.65)	1.445	(1.09)
Interlock dummy	0.106	(1.24)	0.108	(1.24)	0.073	(1.34)	0.102	(1.19)
Year dummies	Yes		Yes		Yes		Yes	
CEO dummies	Yes		Yes		No		Yes	
Firm dummies	No		No		Yes		No	
R^2	0.02		0.03		0.04		0.01	
Observations	18,406		18,406		18,406		18,406	
Panel B: Strong Form RPE Test								
F statistic	7.75		1.62		2.98			
p–value	0.01		0.20		0.08			

coefficient on the industry total return is negative and statically significant, albeit only at the 10% level; for the changes regression in model 2 we find a negative coefficient statistically significant at the 1% level. The economic magnitude of the coefficients is about half of that in Table 2.3 when use the levels of compensation and very similar to Table 2.4 when we use specify the changes in compensation.

We again test for the strong form version of RPE in Panel B of Table 2.5 and in both cases we find evidence in favor of the optimal use of RPE. For both specifications we are unable to reject the null hypothesis of optimal RPE at the 10% level.

While using observed bond prices to compute total returns creates its own challenges, we believe results in Table 2.5 alleviate concerns regarding the sensitivity of our main findings to the calibration of the Merton (1974) model.

2.3.2 Firm–specific regressions

Our results so far are based on pooled regressions controlling for executive and year dummies. One critical assumption we make is that of constant coefficients across time and firms. Though this is a common assumption in the literature, it seems plausible that the sensitivity of compensation to performance could vary by firm or by industry. Some of the early empirical literature on RPE (Antle and Smith, 1986; Janakiraman, Lambert, and Larcker, 1992) use only time series tests for this reason.

In Table 2.6 we estimate the impact of total returns on compensation using firm–specific time series regressions. We require firms to have at least 8 observations to be included in this test, and given the small sample size the only explanatory variables included in the regression are the firm and industry total return, and the log of total assets. A total of 1,322 firms satisfy our requirement of at least 8 observations.

Table 2.5: Market value from observed bond prices

In this table we use observed annual bond returns from TRACE to construct total return from market prices. We estimate the equation $Log(Pay_{it}) = \delta_t + \eta_j + \alpha_1 Firm\ Total\ Return_{it} + \alpha_2 Industry\ Total\ Return_{it} + \beta' Control\ Variables_{it} + \xi_{it}$. For each firm, industry performance is the market capitalization–weighted average performance of all other available firms with the same 2 digit SIC industry classification. Panel B presents a Wald test for the strong form version of RPE where the null hypothesis is $H_0 : \alpha_2/\alpha_1 = -cov(Firm\ Total\ Return, Industry\ Total\ Return)/var(Industry\ Total\ Return)$. The sample spans from 2002 to 2012. Variable definitions are presented in Table 2.1. Heteroskedasticity robust t–statistics clustered at the firm level are in parentheses. The superscripts ***, **, and *, indicate significance at the 1%, 5%, and 10% level, respectively.

Dependent Variable:	Log(Pay)		Δ Log(Pay)	
	Model 1		Model 2	
	Estimate	t-value	Estimate	t-value
Firm Total Return	0.141***	(3.37)	0.352***	(3.57)
Industry Total Return	-0.073*	(-1.80)	-0.202***	(-2.62)
Log of assets	0.314***	(3.70)		
Log of sales	-0.013	(-0.17)		
Market to book ratio	0.082***	(3.38)		
Leverage	0.048	(0.19)		
Return on assets	0.388	(1.51)		
Institutional ownership	0.071	(0.30)		
Stock Volatility	-0.151	(-1.17)		
CEO ownership dummy	-0.086	(-0.70)	-0.240	(-1.25)
CEO chair dummy	-0.001	(-0.02)	0.004	(0.05)
CEO tenure	0.002	(0.06)	0.052	(0.62)
Log of CEO age	1.418**	(2.50)	1.657	(1.28)
Missing Age dummy	5.601**	(2.49)	6.552	(1.27)
Interlock dummy	-0.077	(-0.31)	-0.151	(-0.80)
Δ Log of assets			0.073	(0.35)
Δ Log of sales			-0.081	(-0.49)
Δ Market to book ratio			0.078***	(2.89)
Δ Leverage			0.420	(0.74)
Δ Return on assets			-0.017	(-0.04)
Δ Institutional ownership			-0.213	(-0.54)
Δ Stock Volatility			-0.080	(-0.47)
Year dummies	Yes		Yes	
CEO dummies	Yes		Yes	
R^2	0.32		0.01	
Observations	4,010		3,230	
Panel B: Strong Form RPE Test				
F statistic	0.04		0.00	
p–value	0.83		0.99	

Table 2.6 presents summary statistics of the estimated coefficients across the firm–specific regressions, the last column in the table presents the test statistic of the null hypothesis that the mean coefficient is zero. In panel A we present results for levels of annual compensation while in panel B we use the changes in annual compensation. We find strong statistical evidence in favor of RPE in both empirical specifications, the mean and median of industry total return coefficients are negative and in both panels the test that the mean coefficient is zero is strongly rejected.

Table 2.6: Firm–specific regressions

This table presents summary statistics for the coefficients of RPE regressions estimated separately for each firm in our sample. We require that a firm have at least 8 observations to be included in the estimation. In Panel A the dependent variable in the estimation is Log(Pay) while in Panel B the dependent variable is ΔLog(Pay). The only explanatory variables included in the regression are a constant, Firm Total Return, Industry Total Return, and Log of Assets. For each firm, Industry Total Return is the market capitalization–weighted average of all other available firms with the same 2 digit SIC industry classification. The Strong RPE Statistic is the difference within each firm regression of the ratio of the coefficients of industry to firm total return minus the ratio of the covariance of these two variables to the variance of the industry total return.

	Mean	Median	Std. Dev.	N	*t*-value
Panel A: Dependent variable is Log(Pay)					
Firm Total Return	0.28	0.24	0.96	1,322	10.62
Industry Total Return	-0.22	-0.21	1.80	1,322	4.51
Strong RPE Statistic	0.06	-0.05	31.25	1,322	0.07
Panel B: Dependent variable is ΔLog(Pay)					
Firm Total Return	0.48	0.39	2.31	1,322	7.55
Industry Total Return	-0.31	-0.15	4.44	1,322	2.53
Strong RPE Statistic	-1.30	0.07	112.09	1,322	0.42

Given the small sample size of each firm–specific regression, it does not seem very fruitful to conduct a Wald test of optimal RPE for each regression. Instead, we follow Janakiraman, Lambert, and Larcker (1992) and construct a strong form RPE quantity for each regression and then test if the mean of this quantity is different from zero. We compute this strong form RPE quantity as the ratio of the industry to firm total return coefficients minus the ratio of the firm–specific covariance between firm and industry performance to the firm–specific variance of industry total return.

The third row in each panel presents summary statistics for this strong form RPE quantity. We find evidence in support of optimal RPE in the annual compensation flow. For both empirical specifications the median is very close to zero, and in the last column we see that we cannot reject the test that the mean quantity is different from zero even at the 10% level.

2.3.3 Alternate test of strong–form RPE

Antle and Smith (1986) devise an alternate test of strong–form RPE by noting that an implication of filtering out common shocks is that executives should be compensated only for the unsystematic (or idiosyncratic) part of firm performance.

By definition, the unsystematic performance of the firm is unrelated to that of its peer group. Thus, Antle and Smith (1986) propose to regress firm on industry performance and use the residuals and predicted values of this regression as an estimate of unsystematic and systematic firm performance, respectively.

We follow Antle and Smith (1986) to obtain the systematic and unsystematic components of firm performance and then estimate the impact of each part on CEO compensation in the following equation,

$$
\begin{aligned}
Log(Pay)_{it} = \eta_t + \delta_i + \gamma_1 Systematic\ Performance_{it} \\
+ \gamma_2 Unsystematic\ Performance_{it} + \beta_1 Firm\ Controls_{it-1} \\
+ \beta_2 CEO\ Controls_{it} + \varepsilon_{it} \qquad (2.3)
\end{aligned}
$$

If $\gamma_1 = 0$ in the equation above, then executives are not being compensated for the systematic (or common) part of firm performance. Hence, a test of the null hypothesis $\mathrm{H}_0 : \gamma_1 = 0$ amounts to a test of strong–form RPE.

Janakiraman, Lambert, and Larcker (1992), Bertrand and Mullainathan (2001) and Garvey and Milbourn (2006) estimate models similar to equation (2.3) and all fail to find evidence in support of strong–form RPE when the measure of firm performance are equity returns.

We estimate equation (2.3) in levels and changes of annual compensation flow for both equity and total firm returns as measures of firm performance. Table 2.7 contains the regression results. We observe that the systematic portion of equity returns has a positive and statistically significant coefficient in both levels and changes of compensation, which is a forceful rejection of the strong–form RPE hypothesis. This result is similar to Bertrand and Mullainathan (2001) and Garvey and Milbourn (2006), who call it "pay for luck" since executives are being compensated on a systematic shock over which they have no control.

In models 2 and 4 we use total return as the measure of performance and now results support the strong–form RPE hypothesis. For both levels and changes of annual compensation, only the coefficient for the unsystematic portion of the firm's total return is statistically significant. This suggests that CEOs are not being compensated for the systematic (or common) part of performance, instead they are being

Table 2.7: Alternative test of strong–form RPE

In this table we test an alternate specification of the strong–form RPE test based on Antle and Smith (1986). We estimate the equation $Log(Pay_{it}) = \delta_t + \eta_j + \gamma_1 Systematic\ Firm\ Performance_{it} + \gamma_2 Unsystematic\ Firm\ Performance_{it} + \beta' Control\ Variables_{it} + \xi_{it}$. For models 1 and 3, the measure of performance is the annual equity return, for model 2 and 4 it is the annual total return. For each firm, systematic (unsystematic) performance is the fitted value (residual) from a regression of firm on industry performance, where the latter is the market capitalization–weighted average of all other available firms with the same 2 digit SIC industry classification. Variable definitions are presented in Table 2.1. Heteroskedasticity robust t–statistics clustered at the firm level are in parentheses. The superscripts ***, **, and *, indicate significance at the 1%, 5%, and 10% level, respectively.

Dependent Variable:	Log(CEO Pay)		Log(CEO Pay)		Δ Log(CEO Pay)		Δ Log(CEO Pay)	
	Model 1		Model 2		Model 3		Model 4	
	Estimate	t-value	Estimate	t-value	Estimate	t-value	Estimate	t-value
Systematic Firm Equity Return	0.053**	(2.03)			0.125***	(2.78)		
Unsystematic Firm Equity Return	0.086***	(4.87)			0.191***	(7.99)		
Systematic Firm Total Return			0.031	(0.61)			0.102	(1.27)
Unsystematic Firm Total Return			0.208***	(6.61)			0.358***	(11.31)
Log of assets	0.251***	(6.55)	0.267***	(6.73)				
Log of sales	0.068*	(1.93)	0.074**	(2.14)				
Market to book ratio	0.034	(1.61)	0.036*	(1.68)				
Leverage	-0.367***	(-4.72)	-0.394***	(-5.13)				
Return on assets	1.095***	(7.53)	1.020***	(7.09)				
Institutional ownership	-0.061	(-0.63)	-0.074	(-0.78)				
Stock Volatility	-0.013	(-0.22)	0.039	(0.72)				
CEO ownership Dummy	-0.088	(-1.46)	-0.083	(-1.38)	0.041	(0.62)	0.048	(0.71)
CEO chair dummy	0.025	(0.98)	0.025	(0.98)	-0.028	(-1.01)	-0.023	(-0.84)
CEO tenure	-0.004	(-0.22)	-0.001	(-0.05)	0.079***	(2.96)	0.080***	(3.00)
Log of CEO age	-0.174	(-1.10)	-0.191	(-1.21)	0.324	(1.01)	0.318	(0.99)
Missing Age dummy	-0.773	(-1.21)	-0.841	(-1.32)	1.268	(0.97)	1.254	(0.96)
Interlock dummy	0.082	(0.94)	0.082	(0.95)	0.106	(1.24)	0.108	(1.24)
Δ Log of assets					0.069	(1.10)	0.068	(1.10)
Δ Log of sales					-0.137**	(-2.35)	-0.130**	(-2.25)
Δ Market to book ratio					0.021**	(2.04)	0.022**	(2.01)
Δ Leverage					-0.247*	(-1.78)	-0.238*	(-1.72)
Δ Return on assets					0.502***	(3.78)	0.440***	(3.33)
Δ Institutional ownership					-0.160	(-1.17)	-0.185	(-1.35)
Δ Stock Volatility					0.031	(0.50)	0.075	(1.23)
Year dummies	Yes		Yes		Yes		Yes	
CEO dummies	Yes		Yes		Yes		Yes	
R^2								
Observations	24,207		24,207		18,406		18,406	

evaluated only on the unsystematic portion of performance.

The results in Table 2.7 are in agreement with the findings from the Wald tests in panel B of Tables 2.3 and 2.4, which provide evidence in support of the use of optimal levels of RPE in executive compensation contracts.

2.4 Robustness

In this section we explore the robustness of our main findings to different sources of concern. First, we have defined industry affiliation by a firm's first two digit SIC classification, but it remains an open question if SIC codes are truly effective at industry grouping considering there exist several different industry classification schemes. Second, recent evidence by Frydman and Saks (2010) shows that executive compensation has suffered dramatic changes through the years and some of the stylized facts of compensation of the past thirty years are not observed in previous decades, thus it is possible that our findings about the use of RPE are only a recent phenomenon.

Third, we study if governance affects RPE practices. Bebchuk and Fried (2004), among others, have argued that chief executives enjoy some level of capture over board of directors and are thus able to set their pay in noncompetitive fashion. Fourth, we test if our results hold in industries considered to have high strategic flexibility, where the CEO can choose the level of exposure of her firm to the industry shock. Lastly, a key condition of RPE is that the agent cannot influence the output of her peer group, an assumption likely to be violated in less competitive industries where firms respond to strategic actions taken by their competitors. We next explore the robustness of our results to all these possible issues.

2.4.1 Different industry benchmarks

Previous literature on RPE commonly defines a firm's peer group by its SIC industry classification (Antle and Smith, 1986; Gibbons and Murphy, 1990; Janakiraman, Lambert, and Larcker, 1992; Aggarwal and Samwick, 1999a), however, there exist different classification schemes which may be used instead and it remains an open question which one is superior.

Bhojraj, Lee, and Oler (2003) compare different industry classification schemes and conclude that SIC, NAICS, and the Fama–French industries all share a high degree of correspondence among them, but they argue that the GICS scheme is preferable since it can explain a greater proportion of the cross–sectional variation in firm level returns. On the other hand, Hoberg and Phillips (2010) argue that fixed industry classifications ignore product differentiation, asset complementarities, etc. and argue that industry groups based on a text analysis of firms' annual statements are superior.

We take no stand as to which industry classification is superior, instead we show our results with all these alternative schemes. In Table 2.8 we use the Fama–French 49 industries, the first three digits of a firm's NAICS classification, the first 6 digits of its GICS scheme, and the 100 Hoberg–Phillips industries.[10] We use both empirical specifications, levels and changes of annual compensation, with all industry classifications and for the sake of brevity we omit the point estimates for all firm and executive control variables though they are included in the estimation.

Results in Table 2.8 are broadly in support of our main findings. In all cases a firm's total return is positively correlated with annual compensation, while the

[10] We obtain the Fama–French classification from professor French's website (`http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html`) and the Hoberg–Phillips industries from their data depository (`http://alex2.umd.edu/industrydata/`).

industry total return is negatively associated. When the specification used is in levels of compensation all point estimates are statistically significant at at least the 5% level; when we use changes in compensation we find strong statistical significance for the Fama–French and NAICS classification but the negative coefficients for the GICS and Hoberg–Phillips industry total returns are no longer statistically significant at conventional levels.

In panel B of Table 2.8 we conduct a Wald test for the null hypothesis of optimal use of RPE. For the estimation in levels of compensation, we fail to reject the null of strong form RPE for all industry groupings at least at the 5% significance level. The Wald test is more mixed for the case of changes in compensation, we still cannot reject the null hypothesis for the 3 digit NAICS at the 10% level, but for the Fama–French and Hoberg–Phillips we only fail to reject the test at the 1% level, and for the GICS industry scheme the null is rejected at conventional levels.

Overall, our results in this section with alternative industry definitions are in broad agreement with our main findings that firms filter some common shocks out of the compensation contract of executives. We also find evidence in support of the optimal use of RPE by firms, though for some industry groupings the evidence is not overwhelming.

2.4.2 Different time period

Frydman and Saks (2010) construct a long time series of executive compensation dating back to the 1930s and show that compensation has suffered dramatic changes through the years. In their sample, some of the stylized facts of compensation observed in the past thirty years, such as the high correlation between firm size and compensation, are not observed in prior decades.

Table 2.8: Robustness, different industry definitions

In this table we analyze the robustness of our results using a different industry classification for peer groups. We estimate the equation $Log(Pay_{it}) = \delta_t + \eta_j + \alpha_1 Firm\ Total\ Return_{it} + \alpha_2 Industry\ Total\ Return_{it} + \beta' Control\ Variables_{it} + \xi_{it}$. For each firm, industry total return is the market capitalization–weighted average of all other available firms with the same industry classification. Panel B presents a Wald test for the strong form version of RPE where the null hypothesis is $\mathrm{H}_0 : \alpha_2/\alpha_1 = -cov(Firm\ Total\ Return, Industry\ Total\ Return)/var(Industry\ Total\ Return)$. The sample spans from 1992 to 2012. Control variables are the same as in Tables 2.3 and 2.4, in the interest of space their point estimates are omitted. Heteroskedasticity robust t–statistics clustered at the firm level are in parentheses. The superscripts ***, **, and *, indicate significance at the 1%, 5%, and 10% level, respectively.

Industry Definitions:	Fama–French 49		3 Digit NAICS		6 Digit GICS		Hoberg-Phillips 100	
Dependent Variable:	Log(Pay)	ΔLog(Pay)	Log(Pay)	ΔLog(Pay)	Log(Pay)	ΔLog(Pay)	Log(Pay)	ΔLog(Pay)
Firm Total Return	0.204***	0.353***	0.215***	0.362***	0.212***	0.347***	0.188***	0.344***
	(6.37)	(11.07)	(6.92)	(11.21)	(6.69)	(10.56)	(4.94)	(9.31)
Industry Total Return	-0.091**	-0.147**	-0.170***	-0.194***	-0.115***	-0.077	-0.107**	-0.096
	(-2.06)	(-2.21)	(-4.60)	(-3.27)	(-2.95)	(-1.27)	(-2.46)	(-1.31)
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CEO controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CEO dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.36	0.03	0.36	0.03	0.36	0.03	0.34	0.03
Observations	24,207	18,406	24,088	18,313	24,128	18,348	19,150	15,013
Panel B: Strong Form RPE Test								
F statistic	3.31	4.49	0.01	2.48	2.47	14.48	0.56	5.27
p–value	0.07	0.03	0.93	0.12	0.12	0.00	0.46	0.02

It is possible that our main findings on the use of relative performance evaluation in compensation contracts only applies to our sample period of 1992–2012. In this section we investigate this possibility by estimating our equations (2.1) and (2.2) on the sample of CEO compensation from Frydman and Saks (2010).[11] Given that we need to calibrate the Merton (1974) model to obtain the total return, we are only able to use observations from 1963 to 1991. Moreover, some of the control variables used in our regressions –such as institutional ownership and some CEO characteristics– are not available for this time period, thus we have to use a smaller subset of control variables though we still include year and CEO dummies.

Table 2.9 present regression estimates for both empirical specifications. Our sample size is small, with 2,151 firm–years for 105 unique firms and 432 distinct CEOs. In model 1, estimated on the levels of compensation, we do not obtain significant results; the firm's total return is has a positive coefficient but it is not statistically significant while the industry total return has a positive estimate, inconsistent with RPE, though it is not statistically significant.

In model 2 we estimate the impact of total return on the changes in compensation, and results are suggestive of some RPE. The firm's total return is significantly associated with changes in compensation, and the industry total return has the correct negative sign though it is marginally insignificant. Given the limited number of observations, it is possible that the lack of statistical significance may be due to a low power issue, though we are not able to ascertain if this is really the case.

[11] We thank professor Frydman for making this dataset available on her website (`https://dl.dropboxusercontent.com/u/7804692/Website/page.htm`).

Table 2.9: Robustness, different time period

In this table we analyze the use of RPE in a different time period. We estimate the equation $Log(Pay_{it}) = \delta_t + \eta_j + \alpha_1 Firm\ Total\ Return_{it} + \alpha_2 Industry\ Total\ Return_{it} + \beta' Control\ Variables_{it} + \xi_{it}$. For each firm, industry total return is the market capitalization–weighted average of all other available firms with the same 2 digit SIC industry classification. Panel B presents a Wald test for the strong form version of RPE where the null hypothesis is $H_0 : \alpha_2/\alpha_1 = -cov(Firm\ Total\ Return, Industry\ Total\ Return)/var(Industry\ Total\ Return)$. The sample spans from 1963 to 1991. Variable definitions are presented in Table 2.1. Heteroskedasticity robust t–statistics clustered at the firm level are in parentheses. The superscripts ***, **, and *, indicate significance at the 1%, 5%, and 10% level, respectively.

Dependent Variable:	Log(Pay)		Δ Log(Pay)	
	Model 1		Model 2	
	Estimate	t-value	Estimate	t-value
Firm Total Return	0.068	(1.09)	0.196**	(2.24)
Industry Total Return	0.020	(0.22)	-0.191	(-1.60)
Log of assets	0.226	(1.65)		
Log of sales	0.007	(0.06)		
Market to book ratio	-0.015	(-0.30)		
Leverage	-0.062	(-0.29)		
Return on Assets	2.141***	(4.12)		
Stock Volatility	-0.200	(-1.20)		
CEO chair dummy	0.116***	(3.54)	0.092**	(2.48)
Δ Log of assets			0.385**	(1.99)
Δ Log of sales			-0.216	(-1.28)
Δ Market to book ratio			0.003	(0.07)
Δ Leverage			0.073	(0.23)
Δ Return on assets			0.915	(1.65)
Δ Stock Volatility			-0.248	(-1.15)
Year dummies	Yes		Yes	
CEO dummies	Yes		Yes	
R^2	0.40		0.04	
Observations	2,151		1,908	
Panel B: Strong Form RPE Test				
F statistic	0.84		0.07	
p–value	0.36		0.79	

2.4.3 Governance and RPE

Previous studies argue that executives may capture the board of directors and in effect set their own pay (see Bebchuk and Fried, 2004; Core, Holthausen, and Larcker, 1999). Entrenched CEOs and executives of firms with weak governance could influence their compensation structure away from benchmarking and towards pay without performance. We test this possibility by using a measure of board capture.

Coles, Daniel, and Naveen (2014) argue that CEOs can exert considerable influence in the selection of board members, thus directors that began their tenure at the company after the chief executive is in place may be more sympathetic to the CEO and provide weaker governance mechanisms; Coles, Daniel, and Naveen (2014) present empirical evidence in support of their view. We use their measure of board co–option to test the impact of governance on RPE practice, where board co–option is the percent of directors hired by the company after the CEO began her tenure.

We enhance equations (2.1) and (2.2) to include board co–option and also its interaction with industry total returns. If firms with weak governance do not follow RPE, we expect the interaction term between industry returns and board co–option to be positive, so that more co–opted boards use less RPE in their CEO compensation.

In addition, we allow the impact of board co–option on industry total returns to differ for years when the industry return is positive from when it is negative. Garvey and Milbourn (2006) argue that if CEOs truly control their compensation process they will choose to use RPE asymmetrically, that is, CEO pay will be benchmarked when the industry return is negative but not when it is positive.

Table 2.10 presents regression results. In models 1 we test for the impact of board co–option on industry total returns for the level of compensation. We observe that the impact of board co–option on the level of compensation is positive and statistically significant, matching the result of Coles, Daniel, and Naveen (2014). The coefficient for the interaction of co–option and industry total return, though positive, is not statistically significant. In model 2 we allow for a different impact depending on whether the industry total return is positive or negative, however, none of the estimates are statistically significant. In models 3 and 4 we repeat the same analysis for the change in compensation flow and find similar results where the interaction between industry total return and board co–option is not significant. These results suggest that our main findings are not affected by the governance structure of the firm.

In unreported results, we segment our sample of firm–years by the entrenchment index (E index) from Bebchuk, Cohen, and Ferrell (2009) into entrenched (E index of 5 or above) and non–entrenched (E index below 5). We find that our results still hold in both subsample, which again suggests that weak governance does not invalidate our main findings.

2.4.4 Strategic flexibility and RPE

A crucial assumption for RPE is that the common shock to the industry is exogenous for all firms. Galopan, Milbourn, and Song (2010) argue that while the common shock may be exogenous, the level of firm exposure to the shock may not be. They argue that CEOs may choose how much exposure to have to common industry shocks and change this exposure even in the short run. In their model, a CEO can have private information about the common shock, and steer her company in the direction where it benefits the most from it.

Table 2.10: RPE and board co–option

In this table we analyze the impact of governance on relative performance evaluation. We estimate the equation $Log(Pay_{it}) = \delta_t + \eta_j + \alpha_1 Firm\ Total\ Return_{it} + \alpha_2 Industry\ Total\ Return_{it} + \alpha_3 Co-option + \alpha_4 Industry\ Total\ Return \times Co-option + \beta' Control\ Variables_{it} + \xi_{it}$. For each firm, industry total return is the market capitalization–weighted average of all other available firms with the same 2 digit SIC industry classification. Co-option is the percent of all directors that began their tenure at the firm after the CEO was hired, it is taken from Coles, Daniel, and Naveen (2014). The sample spans from 1992 to 2012. Control variables are the same as in Tables 2.3 and 2.4, in the interest of space their point estimates are omitted. The sample spans from 1992 to 2012. Variable definitions are presented in the Appendix. Heteroskedasticity robust t–statistics clustered at the firm level are in parentheses. The superscripts ***, **, and *, indicate significance at the 1%, 5%, and 10% level, respectively.

Dependent Variable:	Log(Pay)		Log(Pay)		Δ Log(Pay)		Δ Log(Pay)	
	Model 1		Model 2		Model 3		Model 4	
	Estimate	t-value	Estimate	t-value	Estimate	t-value	Estimate	t-value
Firm Total Return	0.207***	(4.14)	0.207***	(4.14)	0.334***	(6.94)	0.334***	(6.94)
Industry Total Return	-0.140**	(-2.11)	-0.139**	(-2.09)	-0.165**	(-2.00)	-0.167**	(-2.01)
Industry Total Return × Co–option	0.094	(0.77)						
Industry Total Return × Co–option × $\mathbb{I}_{Ind.Ret.>0}$			0.048	(0.26)				
Industry Total Return × Co–option × $\mathbb{I}_{Ind.Ret.\leq 0}$			0.141	(0.87)				
Industry Total Return × Δ Co–option					-0.270	(-0.73)		
Industry Total Return × ΔCo–option × $\mathbb{I}_{Ind.Ret.>0}$							-0.458	(-0.89)
Industry Total Return × ΔCo–option × $\mathbb{I}_{Ind.Ret.\leq 0}$							-0.031	(-0.04)
Board Co–option	0.117**	(2.47)	0.124**	(2.51)				
Δ Board Co–option					0.043	(0.56)	0.076	(0.78)
Firm controls	Yes		Yes		Yes		Yes	
CEO controls	Yes		Yes		Yes		Yes	
Year dummies	Yes		Yes		Yes		Yes	
CEO dummies	Yes		Yes		Yes		Yes	
R^2	0.33		0.33		0.03		0.03	
Observations	15,131		15,131		10,800		10,800	

Galopan, Milbourn, and Song (2010) call this strategic flexibility, where firms can choose their level of exposure to industry shocks. In this situation, they argue that RPE in a compensation contract is no longer optimal, and this potentially explains the failure of previous literature to find RPE.

Galopan, Milbourn, and Song (2010) argue that this strategic flexibility is more likely to be found in industries with a high investment opportunity set, so CEOs can choose specific projects that alter the firm's exposure to industry shocks. We follow their methodology and use the market to book ratio and the ratio of research and development (R&D) expenditures to total assets to identify high investment opportunities. For each industry, we use the median market to book ratio or R&D expenditures of its constituent firms, and then we classify those industries above the median of all industries as with high strategic flexibility.

We follow the specification of Galopan, Milbourn, and Song (2010) and use the systematic and unsystematic components of firm performance as the fitted value and residuals, respectively, from a regression of firm on industry returns. We then estimate equation (2.3) only for the sample of firm–years in high strategic flexibility industries. Galopan, Milbourn, and Song (2010) argue that in high flexibility industries, the systematic component of firm performance should have a positive impact on compensation, thus contradicting RPE. In untabulated results, we are able to replicate the qualitative findings of Galopan, Milbourn, and Song (2010) when we use equity returns as the performance metric.

In Table 2.11 we present regression results when we use the total firm return. We observe some loss in statistical significance but results still suggest the use of RPE for this firms. For the sample of firm–years in a high market to book ratio, the industry total return is negative and statistically significant at the 10% for the specification in levels and at the 1% level for the changes in compensation. In the case of high R&D industries, for the levels of compensation the point estimate for the industry return is negative but not statistically significant while for the changes in compensation it is significant at the 5% level.

Overall, our results, though somewhat weaker, still suggest the use of RPE for firms that operate in industries with high strategic flexibility.

2.4.5 Competition and RPE

A central tenet of relative performance evaluation is that the agent cannot influence the output of the peer groups she is evaluated against (see Holmström, 1982). In our study, this implies that a CEO cannot influence the average output of her industry. Gibbons and Murphy (1990) argue this is a sensible assumption since executives have limited interaction with rival CEOs, so the potential for sabotage, collusion, or externalities is not large. On the other hand, Aggarwal and Samwick (1999b) develop a model of product market competition where firm outputs are either strategic complements or substitutes, and find that the level of competition influences the optimal use of RPE in compensation.

We use the Herfindahl index of sales to measure within industry competition and lag it one period with respect to compensation, so that it represents competition at the start of the year. We compute the Herfindahl index as the sum of the square market share, in percentage points, of all firms in the industry for the year. Following Aggarwal and Samwick (1999b) we use the cumulative distribution function (c.d.f.) of the Herfindahl index instead of its raw values. Higher values in the c.d.f. correspond to less competitive industries.

The U.S. Department of Justice considers industries where the Herfindahl index is between 1,500 to 2,500 (out of a total of 10,000) to be moderately concentrated, and

Table 2.11: Robustness, RPE and strategic flexibility

In this table we analyze the use of RPE in industries with high strategic flexibility. We estimate the equation $Log(Pay_{it}) = \delta_t + \eta_j + \alpha_1 Systematic\ Firm\ Total\ Return_{it} + \alpha_2 Unsystematic\ Firm\ Total\ Return_{it} + \beta' Control\ Variables_{it} + \xi_{it}$ for a subsample of firm–years segmented by their market to book ratio and R&D expenditures. *High MTB* represents industries with market to book ratio above the median of all industries, while *High R&D* represents industries with ratio of R&D expenditures to total assets above the median of all industries. For each firm, systematic (unsystematic) performance is the fitted value (residual) from a regression of firm on industry total return, where the latter is the market capitalization–weighted average of all other available firms with the same 2 digit SIC industry classification. The sample spans from 1992 to 2012. Control variables are the same as in Tables 2.3 and 2.4, in the interest of space their point estimates are omitted. Heteroskedasticity robust t–statistics clustered at the firm level are in parentheses. The superscripts ***, **, and *, indicate significance at the 1%, 5%, and 10% level, respectively.

Dependent Variable:	Log(Pay)		Δ Log(Pay)		Log(Pay)		Δ Log(Pay)	
	High MTB		High MTB		High R&D		High R&D	
	Estimate	t-value	Estimate	t-value	Estimate	t-value	Estimate	t-value
Systematic Firm Total Return	0.064	(1.05)	0.049	(0.48)	0.054	(0.67)	-0.016	(-0.11)
Unsystematic Firm Total Return	0.192***	(4.87)	0.344***	(8.93)	0.172***	(3.81)	0.324***	(7.24)
Firm controls	Yes		Yes		Yes		Yes	
CEO controls	Yes		Yes		Yes		Yes	
Year dummies	Yes		Yes		Yes		Yes	
CEO dummies	Yes		Yes		Yes		Yes	
R^2	0.36		0.02		0.36		0.02	
Observations	16,003		12,091		12,993		9,858	

values above 2,500 represent concentrated industries.[12] For our sample, at the first quartile of the Herfindahl c.d.f. the raw value of the index is 800, which suggests a competitive industry. At the third quartile of the c.d.f., the raw value of the Herfindahl index is 2,453 which still points to moderate industry concentration.

We test if the level of competition affect our findings on RPE by enhancing equations (2.1) and (2.2) with the c.d.f. of the Herfindahl index and its interaction with industry total return. If RPE is less used in more concentrated industries, we expect to find a positive coefficient for the interaction of the Herfindahl index and the industry total return.

Estimation results are presented in Table 2.12. we find some weak evidence that RPE is less used in more concentrated industries. The point estimate of the interaction between the industry total return and the c.d.f. of the Herfindahl index is positive, though only marginally significant for the specification in changes of compensation.

The point estimates suggest that the level of RPE is lower in more concentrated industries, where it seems more likely that one firm's actions generate a stronger response in its competitors and thus the assumption that the agent cannot influence the peer group's output is more likely to be violated.

For the regression in changes, a Wald test cannot reject at conventional levels that there is no RPE for the highest level of industry concentration, and it fails to reject at the 1% level that at the third quartile of the c.d.f. there is no RPE.[13]

In unreported results, we also investigate the impact of strategic actions on RPE by restricting our sample to medium and small size firms. It seems unlikely that the

[12] The general guidelines followed by the U.S. Department of Justice with respect to the Herfindahl index can be found at `http://www.justice.gov/atr/public/guidelines/hhi.html`

[13] The null hypothesis for the first test is $\mathrm{H}_0 : -0.318 + 0.301 \times 1 = 0$; for the second test the null is $\mathrm{H}_0 : -0.318 + 0.301 \times 0.75 = 0$.

Table 2.12: Robustness, RPE and competition

In this table we analyze the use of RPE and its interaction with competition levels in industry. We estimate the equation $Log(Pay_{it}) = \delta_t + \eta_j + \alpha_1 Firm\ Total\ Return_{it} + \alpha_2 Industry\ Total\ Return_{it} + \alpha_3 c.d.f.(Herfindahl) + \alpha_4 Industry\ Total\ Return \times c.d.f.(Herfindahl) + \beta' Control\ Variables_{it} + \xi_{it}$. For each firm, industry total return is the market capitalization–weighted average of all other available firms with the same 2 digit SIC industry classification. The c.d.f(Herfindahl) is the cumulative distribution function of the Herfindahl index of sales within an industry. The sample spans from 1992 to 2012. Control variables are the same as in Tables 2.3 and 2.4, in the interest of space their point estimates are omitted. Heteroskedasticity robust t–statistics clustered at the firm level are in parentheses. The superscripts ***, **, and *, indicate significance at the 1%, 5%, and 10% level, respectively.

Dependent Variable:	Log(Pay)		Δ Log(Pay)	
	Model 1		Model 2	
	Estimate	t-value	Estimate	t-value
Firm Total Return	0.208***	(6.60)	0.359***	(11.33)
Industry Total Return	-0.158**	(-2.43)	-0.318***	(-2.93)
Industry Total Return × c.d.f.(Herfindahl)	0.051	(0.46)	0.301*	(1.71)
c.d.f.(Herfindahl)	0.061	(0.76)	0.119	(1.62)
Firm controls	Yes		Yes	
CEO controls	Yes		Yes	
Year dummies	Yes		Yes	
CEO dummies	Yes		Yes	
R^2	0.36		0.03	
Observations	24,207		18,406	

smaller firms within each industry can influence the group output in a significant way, or that actions by this type of firm will create a large strategic response by the bigger players in the industry. We drop all firms with total assets above their industry median, and then we estimate equations (2.1) and (2.2) on the remaining firm–years. Regression results, available upon request, are qualitatively similar to our main findings. The estimated coefficient for the industry total return is negative and statistically significant, and a Wald test cannot reject the null hypothesis of optimal RPE use in this sample.

2.4.6 Additional analyses

We conduct some additional analyses which, in the interest of space, we do not report in table format.

In our analyses we have used a market capitalization–weighted index to construct the industry performance, this could result in a few firms representing most of the industry due to their size. We investigate the robustness of our results to using an equal–weighted index where every firm carries the same weight within an industry. Our main findings are qualitative unchanged when using this equal–weighted index of industry total returns.

Some prior studies of executive compensation (see Aggarwal and Samwick, 1999a,b) use median regressions to estimate pay sensitivities instead of pooled OLS with fixed effects. A few executives receive very large annual compensation and this can potentially bias OLS estimates. In our case, we have taken the natural logarithm of compensation to lessen the impact of these large compensation packages but it remains a possibility our estimates may be overly influenced by them. We reestimate equations (2.1) and (2.2) using median regressions and find that all of our results are unchanged with this technique.[14]

The enactment of accounting rule FAS 123R in 2006 imposed a change in format for accounting for equity–based compensation, as well as increased disclosure requirements for pension, severance, and deferred compensation payments.

The primary rule change for equity–based awards meant that these payouts must be expensed based on the fair value of the award at the grant date. In our main analyses we account for this change in accounting by following the procedure suggested by Kini and Williams (2011) and Coles, Daniel, and Naveen (2014). In addition, we check the robustness of our results to this change in disclosure in two ways. First, we stop our sample in 2005 so that we only use compensation data reported under the old format. Second, we employ an alternate measure of annual compensation flow that includes only salary, bonus, restricted stock awards, and option grants; this alternative measure is not affected by the increased disclosure for pension and deferred compensation. In both cases we find that our main results continue to hold, we still find significant evidence of RPE and we cannot reject the null hypothesis of optimal RPE.

2.5 Discussion

In this essay we revisit the question of RPE in CEO compensation under a different metric of firm performance. While previous literature on RPE has almost exclusively employed equity returns to measure managerial performance, we argue that total firm return is a preferable metric in RPE regressions since the exogenous common shocks analyzed in theory occur at the asset level instead of the levered

[14]As Aggarwal and Samwick (1999a,b), we are not able to include year nor executive dummies in this estimation. The computation of fixed effects in quantile regressions seems to be a topic of growing work in the econometrics literature but most estimators require a very long time series to achieve acceptable bias levels (see Canay, 2011).

equity level. In addition, it is plausible that CEOs are concerned about the total value of the firm since shareholders bear most of the brunt of the agency cost of other stakeholders and some executives have nontrivial stakes of inside debt in their own company.

We obtain estimates of total return by calibrating the credit risk model of Merton (1974) and, separately, by obtaining market returns for public corporate bonds from TRACE. Our results are qualitatively similar with either measure of total returns. Our main findings provide strong evidence that firms use RPE in the compensation of their top executive. Furthermore, we cannot reject the hypothesis that firms use optimal levels of RPE in the sense of Holmström and Milgrom (1987).

Our results are robust to potential biases, such as firm–specific pay sensitivities, different industry composition, strategic flexibility, and the passage of FAS 123R. Further, we find weak evidence of RPE in a different time period. We find weak evidence consistent with a lack of RPE in more competitive industries.

Overall, our paper contributes to the recent discussion about the efficiency of CEO contracting. Bertrand and Mullainathan (2001) and Bebchuk and Fried (2004) suggest that executives enjoy some level of capture over the compensation process, while Gabaix and Landier (2008) show that the rise of executive compensation can be explained within a framework of competitive markets and rare skills. Our contribution is to show that one of the main implications of the principal–agent model, that of relative performance evaluation, seems to be supported by the data. This finding is in line with the view that, in this respect, pay in the CEO labor market is set competitively.

3. SHAREHOLDER BARGAINING POWER, DEBT OVERHANG, AND INVESTMENT

3.1 Introduction to Section 3

A large and influential literature in financial economics (Myers (1977) and onwards) has theoretically and empirically analyzed the underinvestment problem caused by debt overhang. In particular, Hennessy (2004) shows theoretically that debt overhang distorts both the level and composition of investment, while Hennessy (2004), Hennessy, Levy, and Whited (2007), and Chava and Roberts (2008) provide empirical evidence that debt overhang has a substantial negative impact on investment.[15] The economic importance of the investment effect of debt overhang is quite transparent. For example, the potential dampening impact of debt overhang on capital investment has received much recent attention during the relatively slow recovery from the financial crisis of 2007-2008 (see, e.g., Reinhart and Rogoff (2009) and Ochino (2010)).

Intuitively, the underinvestment problem due to debt overhang is caused by the truncation of equity holders' investment horizon at default, so that shareholders do not fully recognize the returns to investment that bondholders receive in default. Hennessy (2004) shows that debt overhang reflects a wedge between the value of investment to the firm and the value to shareholders.[16] However, if shareholders have a strong bargaining position *vis-à-vis* the debt holders, they may be able to extract some of the investment returns from bondholders during default, potentially

[15] Lang, Ofek, and Stulz (1996) show that leverage does not reduce growth for firms known to have good investment opportunities, but is negatively related to growth for firms whose growth opportunities are either not recognized by the capital markets or are not sufficiently valuable to overcome the effects of their debt overhang.

[16] In the Hennessy (2004) framework, the only shareholder-debtholder agency conflict is debt overhang. But, more generally, other shareholder-debtholder conflicts are possible.

mitigating the underinvestment problem. Previous literature emphasizes the role of bargaining in distressed organizations (e.g., Gilson, John, and Lang (1990), Asquith, Gertner, and Scharfstein (1994), and Franks and Torous (1989)). In particular, several empirical studies document substantial deviations from the absolute priority rule (APR) in favor of shareholders.[17] Moreover, as Garlappi and Yan (2011) highlight, the resolution of financial distress includes debt restructuring and debt–equity exchanges that do not necessarily lead to formal bankruptcy filings, suggesting that shareholder recovery is a broader concept than that of APR violations in bankruptcy proceedings.

In this essay, we theoretically and empirically investigate the implications of shareholders' bargaining power during default on the debt overhang and its negative effect on investment.[18] To derive testable predictions on the effects of observable firm-specific characteristics related to shareholder bargaining power (SBP), we construct a dynamic bargaining model between equity and debt holders to analyze the equilibrium firm reorganization during default. In contrast to the reduced form Nash equilibrium solution concept that is often used in the literature to characterize post-default bargaining between equity and debt holders, we build on the dynamic bargaining framework of Stahl (1972) and Rubinstein (1982) and incorporate realis-

[17] In a seminal study, Franks and Torous (1989) document APR violations in 66.67% of their bankruptcy sample during 1970–1984. Several later studies confirm these authors' findings for different time periods: Lopucki and Whitford (1990) find deviations from APR in 48.84% of their bankruptcy sample for 1979–1988; Eberhart, Moore, and Roenfeldt (1990) investigate the period 1979–1986 and find deviations from APR in 76.67% of their sample; Weiss (1990) documents APR violations in 72.97% for bankruptcies during 1980–86; Tashjian, Lease, and McConnell (1996) find deviations from APR in 72.92% of their bankruptcy sample for 1980–1993; Betker (1995) documents APR violations in 72% of his sample for 1982–1990. The APR violations documented in these papers can be economically large. Morellec, Nikolov, and Schurhoff (2012) estimate that, among U.S. firms over the period 1992–2004, the average shareholder recovery is about 20% of the asset value at the time of financial distress.

[18] Franks and Torous (1989) predict (but do not provide empirical support) that APR violations can reduce underinvestment. As pointed out by Hennessy (2004), APR violations in favor of equity mitigate debt overhang similar to the issuance of new secured debt.

tic institutional features of the post-default reorganization process in Chapter 11. In our model, the relative bargaining power of equity and debt holders is endogenous. In particular, the equilibrium expected debt recovery depends on shareholder and bondholder ownership concentration; the expected liquidation value; and, the rate of capital depreciation.

In the Rubinstein-Stahl bargaining model the size of the bargaining object (or the "pie") is fixed and the bargaining power of the players depends on their relative and exogenously given subjective rates of time discount — that is, the more patient player has the greater bargaining power. In contrast, our model realistically allows firm value to evolve stochastically during the bargaining process, thereby creating a stochastic opportunity cost for rejecting offers. Thus, the effective rates of time impatience are not exogenous but depend on firm-specific variables that affect the opportunity cost of rejecting the other party's offer and coordinating a counteroffer. Under the reasonable assumption that ownership concentration improves coordination and generation of counteroffers, our model predicts that debtors' equilibrium recovery — or the debt overhang as defined by Hennessy (2004) — is increasing in bondholders' ownership concentration, but decreasing in shareholder ownership concentration. In a similar vein, the debt overhang is increasing with the expected liquidation value of the firm, which accrues to the debtors in case that the two parties cannot achieve an agreement in a finite time period.

Previous estimates of debt overhang in the literature inferred default probabilities indirectly from coarse credit ratings of firms. We instead construct a new measure of the debt overhang correction where default probabilities are estimated directly from a best–of–breed hazard model of bankruptcy (see Chava and Jarrow (2004)). This allows us to avoid the debate that questions bond ratings' ability to correctly assess a firm's risk of default (see White (2010)); in addition, it allows us to estimate the debt overhang correction for a larger sample of firms for which overhang may be economically important. We show that our measure encompasses the overhang proxy used by Hennessy (2004) and Hennessy, Levy, and Whited (2007) and the economic impact of debt overhang is significant in the sample of firms where we can estimate our overhang correction measure, but a credit rating–based overhang correction proxy cannot be estimated.

Using this new measure of debt overhang correction and empirical proxies of the variables implicated by our model, we find support for the main predictions of the model. We enhance the q–investment specifications of Hennesy (2004) and Hennesy, Levy, and Whited (2007) and find that SBP significantly mitigates the underinvestment effects of debt overhang. Specifically, controlling for Tobin's q, cash flows, and debt overhang, we find that the negative investment effect of the debt overhang is mitigated by higher shareholder ownership concentration, but exacerbated by greater bondholder ownership concentration and expected liquidation values. Moreover, consistent with the role of the depreciation rate in our sample, higher depreciation rates ceteris paribus raise investment and mitigate the underinvestment effects of debt overhang.

We test for causality in our results by exploiting two quasi–natural experiments, the changes in bankruptcy law in 1978 and 2005. These two exogenous events affected the SBP in default while leaving the investment opportunity set of firms unchanged. We show that the underinvestment effect of debt overhang decreases when the law change benefits SBP, and then increases when the law change reduces SBP.

In robustness tests, we show our results remain qualitatively unchanged to different default probability models or extracting default intensities from the market prices of credit default swaps. Further, our results are not sensitive to common problems in q–investment regressions, such as measurement errors and possible endogeneity between investment and growth opportunities. Our main results are qualitatively unchanged using the higher–order moment estimator of Erickson and Whited (2000, 2002, 2012), and the instrumental variables approach proposed by Biorn (2000) and Almeida, Campello, and Galvao (2010). The statistical and economic importance of debt overhang remains roughly constant across estimation methods, suggesting these common problems in q investment regressions do not influence our results.

To our knowledge, this is the first study to theoretically develop and empirically test predictions regarding the mitigating effects of shareholder bargaining power on the dampening influence of debt overhang on investment. Theoretically, this is the first analysis to utilize a dynamic (or extensive form) model of bargaining between shareholders and creditors in default to motivate a structural construction of debt overhang through the incorporation of observable firm-specific state variables. In particular, this appears the first analysis to give a bargaining motivation for the role of debt holder ownership concentration and the depreciation rate in the post-default outcome.

Empirically, while previous studies provide evidence that shareholder bargaining power produces significant *ex ante* effects on the decisions of bondholders (Davydenko and Strebulaev (2007)) and shareholders (Garlappi, Shu, and Yan (2008), Garlappi and Yan (2011)), our study is the first to show the effects of variables related to SBP directly on the debt overhang and, therefore, on capital investment. It is noteworthy that while the existing empirical literature uses exogenous renegotiation frictions, in our analysis these are endogenously derived in a strategic bargaining equilibrium. In particular, our model predicts and we empirically verify a negative relation of bondholder ownership concentration and SBP, validating the hypothesis of coordination benefits of ownership concentration for debtors during their negotiations with shareholders in default. In contrast, the literature generally *assumes* that shareholders benefit from dispersed debt ownership during default.

The debt overhang empirical measure we construct is also of interest from an empirical perspective. First, we are able to side–step the criticism of credit ratings and their accuracy. Second, we can compute the overhang correction term for a larger sample of firms. Third, we are able to estimate default probabilities at the firm level (allowing for different default probabilities for firms within a same credit rating class). Fourth, our overhang correction includes default probabilities that are dynamically updated based on the firm's financial and stock market performance. Finally, the default probabilities do not depend on a particular credit rating agency opinion or their changing standards but, instead, are generated from a hazard model of default that has a proven out–of–sample performance.

The remainder of the paper is organized as follows. In Section 1, we provide the model of post-default bargaining and generate empirical predictions regarding the effects of shareholder bargaining power on debt overhang and investment. Section 2 explains the empirical test design, while Section 3 describes the data sources. We present the empirical results in Sections 4. Section 5 discusses the quasi–natural experiment of changes in the bankruptcy code. We analyze the robustness of the results in Section 6. We then summarize our results and conclude.

3.2 Shareholder bargaining power and investment

We consider a levered firm with a stationary debt structure. As in Leland and Toft (1996), the firm continuously issues debt of a fixed maturity at a constant principal and coupon rate. If it remains solvent the firm redeems the principal at par at maturity. Thus, the firm has a constant debt service of b while solvent. However, the firm has the option to strategically default at any point. We first describe the firm's investment environment and derive the optimal investment policy. We then endogenize the post-default game and derive refutable predictions on the effects of shareholder bargaining power on the debt overhang and investment.

3.2.1 Optimal investment

At each instant in time, the operating profits of the firm $\pi(K, \varepsilon)$ are determined by the existing capital stock K and a productivity shock ε. The laws of motion for K and ε are:

$$dK_t = (I_t - dK_t)dt \tag{3.1}$$

$$\frac{d\varepsilon_t}{\varepsilon_t} = \mu dt + \sigma dZ_t \tag{3.2}$$

Here, I is the investment, d is the depreciation rate of capital, $\mu > 0$ is a drift parameter, and Z_t is a Wiener process. The total cost of changing capital stock — that is, the total investment cost — is given by $C(I, K)$. In the usual way, this cost includes fixed costs, capital costs, direct investment costs, and capital adjustment costs. Managers of the firm maximize shareholders' residual value. At each instant, given the state $(K\_\{t\}, \varepsilon\_\{t\})$, and adapting to the standard filtration, the firm optimally chooses whether to default on the debt or, conditional on continuation, the investment I_t. We will denote the strategically chosen (and hence stochastic) default date by T.

At default there can be violations of APR so that shareholders receive the value $\Omega(K_T, \varepsilon_T)$, gross of direct bankruptcy costs.We will endogenize the APR violations below. Then using the risk-neutral measure $\mathbb{Q}$ (equivalent to the physical probability measure generated by Eq. (3.1)-(3.2)), we can write the firm's optimization problem as a combination of optimal stopping time and investment problems,

$$W^S(K_0, \varepsilon_0) = \max_{I \in \mathcal{R}_+, T} \mathbb{E}_0^{\mathbb{Q}} \Big[\int_0^T e^{-rt} [\pi(K_t, \varepsilon_t) - C(I_t, K_t) - b] dt + e^{-rT} \Omega(K_T, \varepsilon_T) \Big] \quad (3.3)$$

We will model the derivation of shareholders' value at default as follows. Conditional on (K_T, ε_T), shareholders and creditors attempt to renegotiate the debt by making a debt-for-equity swap. If the renegotiation is successful, creditors receive $\theta(K_T, \varepsilon_T)$ of the value of the (now) unlevered firm; but if the renegotiation is unsuccessful, the firm is liquidated according to APR, and the shareholders receive 0. Then letting $V^U(K_T, \varepsilon_T)$ denote the value of the unlevered firm at T with the state (K_T, ε_T)[19] and B the bankruptcy costs (expressed as a proportion of the continuation firm value at bankruptcy), we get

$$\Omega(K_T, \varepsilon_T) = \max \left[0, (1 - \theta(K_T, \varepsilon_T)) V^U(K_T, \varepsilon_T)(1 - B) \right] \quad (3.4)$$

We will endogenously derive θ in the next Section. In particular, we will show that along the equilibrium path $\theta(K, \varepsilon)$ is continuously differentiable in its arguments. Furthermore, the optimal policy for the firm is as follows: For every K, there exists $\varepsilon^*(K)$ such that the firm is continued at t if $\varepsilon_t \geq \varepsilon^*(K_t)$, and there is default else. And the present value of shareholders' payoffs in default along the equilibrium path, $\Omega^*(K_T, \varepsilon_T)$, are given by the non-zero component of Eq. (3.4). Then, using the stochastic process on productivity shocks, we can write the pointwise optimality

[19]That is, $V^U(K_\tau, \varepsilon_\tau) = \max_{I \in \mathcal{R}_+} \mathbb{E}_\tau^{\mathbb{Q}} \Big[\int_\tau^\infty e^{-rt} [\pi(K_t, \varepsilon_t) - C(I_t, K_t)] dt \Big]$. We note that because the productivity shocks follow a geometric Brownian motion with positive drift (cf. (3.2)), $V^S(\cdot, \varepsilon)$ is continuous in ε and strictly increasing in it.

conditions for (3.3) as the Bellman equation

$$\begin{aligned} rW^S(K,\varepsilon) &= \max_{I\in\mathcal{R}_+}\{\pi(K,\varepsilon)-C(I,K)-b+(I-\delta K)W_K^S(K,\varepsilon) \\ &\quad + \mu\varepsilon W_\varepsilon^S(K,\varepsilon)+\sigma\varepsilon W_{\varepsilon\varepsilon}^S(K,\varepsilon)\} \end{aligned} \tag{3.5}$$

And the boundary and smooth pasting conditions (see, e.g., Karatzas and Shreve (1988))

$$W^S(K_T,\varepsilon_T) = \Omega^*(K_T,\varepsilon_T) \tag{3.6}$$

$$W_x^S(K_T,\varepsilon_T) = \Omega_x^*(K_T,\varepsilon_T), x\in\{K,\varepsilon\} \tag{3.7}$$

It then follows from (3.5) that the optimal investment policy pointwise satisfies

$$C_I(I^*,K)=W_K^S(K,\varepsilon)\equiv q(K,\varepsilon) \tag{3.8}$$

where $q(K,\varepsilon)$ is the marginal q. To derive an empirically version of (3.8), we will parameterize the adjustment cost function to have both convex and non-convex components, as suggested by Cooper and Haltiwanger (2006). Hence, the total investment costs are

$$C(I,K)=a(K)+pI+\frac{f}{2}\left(\frac{I}{K}\right)^2 K \tag{3.9}$$

Here, p is the unit direct investment cost, $a(K)$ are fixed costs that include the non-convex component of adjustment costs, and the last component of Eq. (3.9) are the convex adjustment costs (see Cooper and Haltiwanger (2006)). Plugging this in Eq. (3.8) yields an optimal investment equation that is linear in the marginal q :

$$\frac{I}{K}=\alpha+\gamma q(K,\varepsilon) \tag{3.10}$$

where $\alpha \equiv -p/f, \gamma = 1/f$. Now, to express (3.10) in terms of the *average* $q \equiv Q$, we use the following result:

Proposition 1. *At any $t \in [0, T)$, the marginal* q, *conditional on the state (K_t, ε_t), is related to the Q according to:*

$$q(K_t, \varepsilon_t) = Q(K_t, \varepsilon_t) - \frac{\mathbb{E}_t^{\mathbb{Q}}\left[e^{-r(T-t)} \left\{\theta(K_T, \varepsilon_T)V^U(K_T, \varepsilon_T)(1-B)\right\} \Big| K_t, \varepsilon_t\right]}{K_t} \tag{3.11}$$

Using (3.11) in (3.10), we then get an estimable equation of the form:

$$\frac{I}{K} = \alpha + \psi_1 Q - \psi_2 \left(\frac{V^U(1-B)}{K}\right) + \psi_3 \left(\frac{(1-\theta)V^U(1-B)}{K}\right) \tag{3.12}$$

where, theory imposes the restriction $\psi_1 = \psi_2 = \psi_3 = \gamma$. As in Hennessy (2004) and Hennessy, Levy, and Whited (2007), Eq. (3.12) enhances the standard q-theory based investment relation with the negative effects of the debt overhang — effectively the second term in the right-hand-side. However, the innovation here is the offsetting effect of shareholder bargaining power (SBP), represented by the last item in the right-hand-side. To give this investment model empirical content we need refutable predictions on the drivers of SBP. In the next section, we endogenize SBP (θ) and derive these predictions through comparative statics.

3.2.2 Post-default bargaining

Following default at T, shareholders and creditors attempt to renegotiate the debt through a mutually acceptable debt-for-equity swap θ, which represents the creditors' share of cash flows in the reorganized all-equity (or unlevered) firm. We model this bargaining through alternating proposals in a manner that is consistent with practice. In Chapter 11 reorganizations, the corporation has a fixed time period (typically 120 days) to file for a reorganization plan, which the creditors can accept or reject.[20] Following this timing protocol, we assume that in the bargaining game shareholders move first and θ to the creditors. If creditors reject this proposal, they are expected to devise an alternate plan that is offered to equity holders, and the process continues till an agreement is reached, or the firm is liquidated. For simplicity, we assume that the firm suspends investment and the evolution of the productivity process is suppressed till a settlement is reached.[21]

The situation at hand is consistent with the Rubinstein (1982) model of sequential bargaining where the objective is the division of the 'pie' $V^U(K_T, \varepsilon_T)$.[22] As is well known, along the equilibrium path, the first offer with the share being determined by the subjective discount rates of the bargaining parties. We posit that in the situation at hand the discount factors for creditors and equity holders will depend on the time required to develop counteroffers. Intuitively, if creditors/shareholders know that a relatively long time will be required to develop and finalize counteroffers from their side, then they are less likely to reject offers because of the higher opportunity costs from delayed resumption of cash flows. Furthermore, the literature suggests that the time for developing and responding to offers is negatively related to the ownership concentration because greater concentration, ceteris paribus, reduces the coordination costs (Davydenko and Strebulaev (2007) and Aslan and Kumar

[20]Grinblatt and Titman (2002, Chapter 16) provide a good summary of the U.S. bankruptcy process.

[21]The assumption of suspended investment during the renegotiations, while made for simplicity here, is not unrealisitic since major new investment programs are typically not undertaken (or allowed) during active renegotiations between creditors and equityholders.

[22]Stahl (1973) models a finite offer bargaining game, while Rubinstein (1982) does not restrict the number of offers ex ante. In practice, Chapter 11 reorganizations typically do not have fixed (or common knowledge) time limits ex ante. And since the number of offers and counter offers can be arbitrarily large, the Rubinstein (1982) model appears to be a reasonable approximation of the post-default bargaining game.

(2012)). For empirical content, we represent the ownership concentration through the Herfindahl-Hirschman Index (HHI) at the time of default, which we denote by HH_S and HH_D for equity and debt ownership, respectively.[23] We model the coordination time through the existence of bounded functions $\xi_j(HH_j) : [0,1] \to \mathbb{R}_{++}$, $j = S, D$, that are each decreasing on $(0,1)$. The discount factors for creditors and shareholders are then represented by $\delta^j = e^{-(r+\xi_j)}, j = S, D$. And the alternate offers are made at times $\tau_1 = T + \xi_S, \tau_2 = T + \xi_S + \xi_D$, and so on.

Now, let $\bar{B}$ represent the direct bankruptcy costs as a proportion of the continuation value of the firm in default. Then, based on Rubinstein (1982), we can characterize the post-default bargaining outcome as follows.

Proposition 2. *The shareholders' initial offer* $\theta^* = \frac{\delta^D(1-\delta^S)}{1-\delta^S\delta^D}$ *is accepted by the creditors. Hence, under the risk neutral equivalent measure,* $\Omega^*(K_T, \varepsilon_T) = e^{-(r+\xi_S)}(1 - \theta^*)V^U(K_T, \varepsilon_T)(1 - \bar{B})$.

Note that we recover the expression for shareholder value in default given in Eq. (3.4) by putting $(1 - B) \equiv e^{-(r+\xi_S)}(1 - \bar{B})$, where B is now interpreted to include both the direct and indirect cost of bankruptcy, where the indirect costs refer to the opportunity costs of cash flow disruption from debt renegotiation.

The creditors' equilibrium share in the continuation value of the firm is (θ^*) in Proposition 2 is clearly decreasing in the shareholders' discount rate δ^S, but it is increasing in the creditors' discount rate δ^D. Given the negative relation of coordination time and ownership concentration, we get,

Corollary 1. *The shareholders' (creditors') equilibrium value following default is increasing (decreasing) in shareholder ownership concentration, but is decreasing (increasing) in bondholder ownership concentration.*

[23] That is, $HH_j, j = S, D$, are the sum of squares of the ownership fractions of equity and debt at T.

With the characterization of the post-default bargaining available, we can now characterize the optimal stopping time or strategic default policy of the firm.

3.2.3 Strategic default

We first provide a heuristic intuition on the trade off in the strategic default decision. Fix any time period t while the firm is solvent, with the state state (K_t, ε_t). If the firm declares bankruptcy then shareholders receive $\Omega^*(K_t, \varepsilon_t)$. However, if the firm does not default and expects to continue to recycle debt and pay the constant coupon, then it is indifferent between default and continuation when

$$V^U(K_t, \varepsilon_t)\left[1 - (1 - \theta^*)(1 - B)\right] - \frac{b}{r} = 0 \tag{3.13}$$

Since $V^U(K_t, \varepsilon_t)$ is continuous in its arguments, it follows that the strategic default policy can be states as:

Proposition 3. *There exists a non-increasing function $\varepsilon^* : \mathcal{R}_+ \to \mathcal{R}$ such that given the state (K_t, ε_t), the firm continues operation if $\varepsilon_t \geq \varepsilon^*(K_t)$, but defaults if $\varepsilon_t < \varepsilon^*(K_t)$.*

3.2.4 Model extensions

The characterization of the post-default bargaining outcome (cf. Proposition 2) is elegant and convenient, but comes at some loss of realism with respect to the debt renegotiation process in practice. We focus on two assumptions in the Rubinstein (1982) set-up that require modification. First, the size of the 'pie' in debt renegotiations clearly does not remain fixed during the bargaining process. In particular, we expect economic depreciation of capital to continue while the post-default bargaining takes place. Second, in practice, both creditors and shareholders know that offers can not be made ad infinitum. For example, Chapter 11 reorganizations are undertaken under close judicial supervision, and typically both the debt and equity holders are provided fixed timelines for response. Moreover, it is common knowledge that if there is no agreement beyond a certain time-frame, then the firm will be liquidated. In an unreported extension, we analyze a bargaining model where capital continues to depreciate during the renegotiation and if shareholders and creditors do not come to an agreement after N offers and counter offers, then the firm is liquidated and the debtors receive the liquidation value V^L. In addition to Corollary 1, this extension delivers the following refutable predictions.

Corollary 2. *The shareholders' equilibrium value following default is decreasing in the liquidation value and increasing with the rate of depreciation of the capital stock.*

Intuitively, high liquidation value acts to raise the creditors' discount rate, while a high rate of economic depreciation of capital lowers their discount rate.

3.3 Empirical test design

We now turn to the empirical testing of the optimal investment equation derived in Eq. (3.12), based on the predictions regarding the determinants of SBP specified in Corollaries 1 and 2. To motivate our empirical specification, it is useful to start with the q–investment regression specification that includes a debt overhang wedge correction ($OverhangW$), which is essentially the difference between the marginal and average q given in Proposition 1.

$$\frac{I_{t+1,i}}{K_{t,i}} = \alpha_i + \eta_{t+1} + \beta_1 Q_{t,i} + \beta_2 \frac{CF_{t+1,i}}{K_{t,i}} + \beta_3 OverhangW_{t,i} + \varepsilon_{t+1,i} \qquad (3.14)$$

We include firm and year fixed effects in addition to firm cash flow as explanatory variables.[24] Thus, the rate of investment (I) normalized by the start-of-period capital stock (K) is explained by a firm and year effect plus the start-of-period average Q, cash flow generated during the year (CF), and a debt overhang correction. Specifications similar to equation (3.14) have been used extensively in the previous literature on corporate investment, such as Hennessy (2004), Hennessy, Levy, and Whited (2007), Chava and Roberts (2008), Bakke and Whited (2010), and Thakor and Whited (2011), among others. Our model implies that the specification in (3.14) should be enhanced to include proxies for shareholder bargaining.

However, one has to be careful in introducing individual shareholder bargaining proxies in (3.14) because the empirical estimates of the debt overhang *should already include* the effects of SBP. Hence, to meaningfully test the effects of individual proxies of shareholder bargaining power, we first need to use estimates of debt overhang that exclude the effects of bargaining power. We will specify our methodology for excluding the overhang measure of the effects of shareholder bargaining power momentarily. Here, we will denote such a measure of debt overhang by $OverhangW_{t,i}^{APR}$ to indicate that this measure is based on the assumption that the APR being followed — that is, there is no role for shareholder bargaining power. We then estimate the following equation:

$$\begin{aligned} \frac{I_{t+1,i}}{K_{t,i}} &= \alpha_i + \eta_{t+1} + \beta_1 Q_{t,i} + \beta_2 \frac{CF_{t+1,i}}{K_{t,i}} + \beta_3 OverhangW_{t,i}^{APR} \\ &+ \beta_4 OverhangW_{t,i}^{APR} \times SBP_{t,i} + \beta_5 SBP_{t,i} + \varepsilon_{t+1,i} \end{aligned} \tag{3.15}$$

Hence, we test for the effects of individual proxies for SBP through their interaction

[24] We include cash flow due to the extensive evidence of its effect on investment (Fazzari, Hubbard, and Petersen (1988)).

with the APR-based debt overhang wedge. We now present our estimation methodology for the debt overhang wedge.

3.3.1 Debt overhang wedge measures

Our proposed measures of debt overhang are:

$$OverhangW_{t,i}^{Hazard} = \frac{D_{t,i}}{K_{t,i}} \times \text{Recovery Rate} \times \left[\sum_{s=1}^{20} \rho_t[1 - 0.05(s-1)] \times r_{t+s}\right] \quad (3.16)$$

$$OverhangW_{t,i}^{APR} = \frac{D_{t,i}}{K_{t,i}} \times (1-\gamma) \times \left[\sum_{s=1}^{20} \rho_t[1 - 0.05(s-1)] \times r_{t+s}\right] \quad (3.17)$$

Where $D_{t,i}$ represents the face value of debt, ρ_t is the default probability at time t, γ is the proportional cost of financial distress, r_{t+s} represents the price of a zero coupon bond of maturity s in year t[25], and the Recovery Rate is the industry recovery ratios from Altman and Kishore (1996). Estimates of the cost of financial distress in previous literature vary from as low as 3% (Weiss (1990)) to as high as 20% (Andrade and Kaplan (1998)), we choose a value of γ of 10%, though our results are qualitatively unchanged for different choices. Of course, the specification of a uniform γ ignores the inter-industry variation. We will therefore perform robustness analysis on this specification below.

Hennessy (2004) estimates the probability of default ρ_t by using Moody's hazard rates by bond ratings, obtained from Keenan, Hamilton, and Berthault (2000). Moody's computes this default hazard as the historical average default of corporate bonds s years after issuance, grouped by bond rating, for the period 1920–1999. This choice effectively restricts the sample of firms for which debt overhang can be

[25]We thank Professor J. Huston McCulloch for making these rates available at his website at `http://www.econ.ohio-state.edu/jhm/ts/ts.html`

computed to firms with credit rating. Furthermore, credit ratings based default measures assign the same default probability to all firms within a credit rating class even though investors may not perceive them as the same credit risk (as evidenced by different yields for bonds with the same credit rating).

Our base estimate for the debt overhang wedge ($OverhangW_{t,i}^{Hazard}$) utilizes a hazard model to forecast the default probability ρ_t. We build on the large default risk literature and directly estimate a hazard model for firm bankruptcies (as in Chava and Jarrow (2004)) to generate the firm–level default probabilities required for overhang correction computation.[26] The new overhang correction that we compute has a number of advantages compared to the credit rating–based overhang correction of Hennessy (2004) and Hennessy, Levy, and Whited (2007).

Specifically, we estimate a discrete-time hazard model to predict the default probabilities according to Shumway (2001) and Chava and Jarrow (2004). The hazard model allows us to estimate a default probability for each firm–year, using the most recent available accounting and market information without relying on the availability of a bond rating. In addition, we steer clear of the debate that questions credit rating agencies ability to correctly assess a firm's default risk (White (2010)). The discrete–time hazard model has been shown to out–perform other extant bankruptcy prediction models in out–of–sample forecasts (Chava and Jarrow (2004) and Chava, Stefanescu, and Turnbull (2011)).

To estimate $OverhangW_{t,i}^{APR}$, we introduce a second modification (in addition to using the hazard model), namely, we do not use the recovery ratio from Altman and Kishore (1996) but instead assume that APR is followed. The recovery ratios in

[26] Altman and Hotchkiss (2005) provide an extensive survey of default prediction methodologies. Chava, Stefanescu, and Turnbull (2011) compare the performance of various models in predicting the loss distribution and show that the dynamic hazard model of Shumway (2001) and Chava and Jarrow (2004) performs best in out–of–sample comparisons. Moreover, they show that the specification of the default model has a larger impact than that of the recovery rate model.

Altman and Kishore (1996) represent average recoveries aggregated to the industry level. Based on our model, these recovery ratios *already* include the average level of SBP in the industry. In order to better gauge how the debt overhang underinvestment varies with shareholder power, we construct our debt overhang measure as if APR was followed. We do so by assuming that the recovery ratio of bondholders is one minus a financial distress cost. This in fact represents the debt overhang correction when bondholders enjoy all bargaining power, which serves as a suitable benchmark to test the effect of nonzero levels of shareholder power.[27]

3.3.2 Measures of shareholder power

We employ six proxies for the determinants of SBP mentioned in Corollaries 1 and 2. The proxies we use are: An estimate of the liquidation value of the firm; the percentage of outstanding equity held by institutional investors; the number of institutional investors per dollar of equity holdings; the number of outstanding debt issues normalized by leverage; lack of a public debt rating; and, the depreciation rate as declared by the firm in their annual statement.

As shown in our model, shareholders of firms with high liquidation value have low bargaining power since debt holders have the option of forcing liquidation, thus this value represents a floor for debt holders' recovery. Our measure of expected liquidation value comes from Berger, Ofek, and Swary (1996) and Almeida and Campello (2007), who use proceeds from discontinued operations in a sample of Compustat firms to evaluate the expected asset liquidation value. We normalize this expected liquidation value by the capital stock.

[27]Where possible, we further conduct a minor refinement to our debt overhang estimate by relaxing the assumption that debt matures in a 5% annual linear fashion. If available, we use data items in Compustat (see below) to find the portion of debt that matures in each of the next five years. We assume the rest of the debt matures in an annual straight line from year 6 to 20.

Our next two measures of shareholder power gauge the importance of institutional investors in the firm's shareholder base. Davydenko and Strebulaev (2007) argue that better coordinated and more sophisticated institutional investors are able to bargain more efficiently and induce larger deviations from APR than individual investors. We use the percentage of outstanding equity held by institutional investors as a proxy for the importance of institutions in the shareholder base. In addition, our model shows that the concentration of institutional ownership also matters for bargaining power, as more dispersed institutional ownership can face higher coordination costs. We use the ratio of the total number of institutional investors to total institutional ownership (in dollar terms) as a proxy for concentration in institutional ownership. We obtain the total number of shares held by institutional investors and the total number of investors from the Thomson–Reuters 13f filings database.

We use two measures related to the ownership concentration of debt holders. As shown in our model, more dispersed debt ownership creates larger coordination costs for debt holders and benefits the bargaining power of shareholders. Since data on bondholders' dispersion for non-bankrupt firms is difficult to obtain, extant empirical studies tend to use outstanding bonds as a proxy. We take the log of the number of outstanding bonds for each firm in Mergent's Fixed Income Securities Database divided by the firm's leverage ratio. In addition, we utilize the lack of a bond rating as a proxy for low shareholder power. Firms without a bond rating have been classified in previous literature as bank–dependent for their outside debt financing, and bank debt tends to be much more concentrated than public debt. In addition, Rajan (1992) argues that firms relying on a small number of lenders may be subject to hold–up problems, which lessens shareholder power even more.[28]

[28] As noted at the outset, the prediction of our model with respect to dispersion of credit ownership appears different from some of the papers in the literature. For example, Davydenko and Stebulaev (2007) view dispresed credit ownership as an exogenous renegotiation friction that hurts SBP. Our

3.4 Data sources and sample statistics

Our data source for accounting information is Compustat's North America Fundamentals Annual file for the years 1970 to 2010. We follow Hennessy, Levy, and Whited (2007) in the sample selection by first deleting any firm-year observations with missing data or for which total assets (Compustat data item *at*), the capital stock (*ppegt*), or sales (*sale*) are either zero or negative. We exclude financial firms (SIC 6000–6999), regulated utilites (SIC 4900-4999), and public service firms (SIC greater than 9000). We discard firm–years with real assets or sales growth over 100% or where the capital stock is less than $5 million in real 2000 dollars. A firm is included only if it has at least three consecutive years of available data.

We obtain stock price information from CRSP, and data on institutional holdings from Thomson-Reuters 13f database. Information for the number of public bonds outstanding is sourced from Mergent's Fixed Income Securities Database. The supplemental appendix contains detailed information on the construction of the variables used in our regressions.

3.4.1 Properties of debt overhang estimates

We construct our debt overhang proxies ($OverhangW_{t,i}^{Hazard}$ and $OverhangW_{t,i}^{APR}$) according to equations (3.16)-(3.17) with the default probability being estimated from a hazard model. The bankruptcy data required to estimate the hazard model is from Chava and Jarrow (2004) and Chava, Stefanescu, and Turnbull (2011), which we update until 2010. Bankruptcy is defined as the filing of either Chapter 7 or Chapter 11 bankruptcy reorganization plan. The dataset is comprehensive and includes

dynamic bargaining model suggests that debtors will rationally recognize that dispersed credit ownership increases the opportunity cost of rejecting the shareholders' initial offer, and therefore dispersed credit ownership need not hurt SBP.

the majority of bankruptcies during 1962-2010. We merge this database with Compustat and CRSP to create a comprehensive dataset of default history, firm level balance sheet data, and market returns for the period 1962–2010.

We create an indicator variable for each firm-year that takes the value of one the year a firm defaults, and zero otherwise. Some firms get delisted from the stock exchange and default at a later date; we follow Shumway (2001) and code the year of delisting as the year of default in cases where the firm defaults within five years after delisting. We lag all accounting and market data by at least six months with respect to the default date so that there is no look–ahead bias.

Following Shumway (2001) and Chava and Jarrow (2004), we use the following stock market and accounting variables to forecast default probability: the ratio of net income to total book assets (NI/TA), the ratio of total liabilities to total book assets (TL/TA), the logarithm of the firm's equity value divided by the total NYSE/AMEX/NASDAQ market capitalization at the end of each calendar year (*Relative Size*), the return of the firm minus the value-weighted CRSP NYSE/AMEX/NASDAQ index return for the previous calendar year (*Excess Return*), and the standard deviation of the residuals from a market regression of monthly returns from the previous calendar year ($Sigma$).[29]

We expect default probabilities to increase with the ratio of total liabilities to total assets, and increase in the standard deviation of the firm's returns. Conversely, an increase in relative size, excess returns, or the ratio of net income to total assets would signal lower firm risk; hence we expect default probabilities to decrease.

Table 3.1 presents the estimation results. We have a total of 135,447 firm–year observations and 1,455 default instances in our sample. All of our coefficients have

[29] We obtain qualitatively similar results when we use a simpler version of the hazard model where we replace *Relative Size* by the log of market capitalization and *Sigma* by the stock return volatility.

the expected sign and all are highly statistically significant; their magnitudes are comparable to those of Shumway (2001), Chava and Jarrow (2004) and Chava, Stefanescu, and Turnbull (2011). One minor difference with Shumway (2001) is in the NI/TA coefficient, where the author finds a statistically insignificant negative coefficient. Our larger dataset allows us to find marginal statistical significance for the negative coefficient.

Table 3.1: Hazard model of default

This table presents estimates from a hazard model with market and accounting variables similar to Shumway (2001) and Chava and Jarrow (2004). The sample excludes financials, utilities, and government entities and covers the period 1962–2010. The dependent variable is an indicator variable that takes the value of one the year a firm exits the sample due to bankruptcy, and zero otherwise; there are 1,455 bankruptcies in the sample. The independent variables are lagged by at least six months with respect to the bankruptcy date. Variable definitions are in the Appendix. Standard errors are clustered by firm. The superscripts ***, **, * indicate the coefficient is significant at the 1%, 5%, and 10% level, respectively.

	Coefficient	t-value	p-value
NI/TA	-0.154*	-1.718	0.086
TL/TA	3.217***	31.800	0.000
Relative Size	-0.196***	-11.449	0.000
Excess Return	-1.215***	-12.054	0.000
Sigma	3.902***	14.329	0.000
Constant	-8.158***	-81.297	0.000
Pseudo R^2	0.18		
Observations	135,447		

3.4.2 Sample statistics

Table 3.2 presents descriptive statistics for our variables of interest, including our proposed measures of debt overhang computed with (3.16)-(3.17) ($OverhangW_{t,i}^{Hazard}$

and $OverhangW_{t,i}^{APR}$) and we compare it with the overhang wedge of Hennessy, Levy, and Whited (2007) ($Overhang_{t,i}^{hlw}$). To lessen the impact of outliers, all variables are winsorized at the 1^{st} and 99^{th} percentile of the pooled distributions. We use the market-to-book ratio of assets as a proxy for Tobin's q (bounded above at 10). Our sample consists mostly of large firms with positive free cash flow, even at the 25th percentile of the pooled distribution, and valuable investment opportunities (Tobin's q larger than unity).

Panel A of Table 3.2 presents summary statistics for the debt overhang proxy $OverhangW_{t,i}^{APR}$ (calculated from Equation (3.17) and compares it with the one estimated following Hennessy, Levy, and Whited (2007) ($OverhangW_{t,i}^{hlw}$). Our measure of debt overhang is, on the median, about three times smaller than $OverhangW_{t,i}^{hlw}$, though the standard deviation is actually larger, suggesting a large dispersion. We are able to estimate debt overhang for about 37% more firm–years with our new measure.

Panel B of Table 3.2 presents Pearson correlation coefficients between investment and the overhang proxies. The Pearson coefficients show a negative albeit small correlation between investment and overhang, given the large sample size all these correlations are statistically significant. The correlation between both debt overhang proxies is positive and moderately high.[30]

In unreported results we validate our measure against the Hennessy, Levy, and Whited (2007) proxy in q-investment regressions. We find that our proxy has a significant negative impact on investment, and when we include both overhang wedge measures we find that our measure subsumes the one from Hennessy, Levy, and Whited (2007). The economic impact is significant as well, a one standard deviation

[30]The correlation between both debt overhang measures is more than just a leverage connection. As mentioned in Hennessy (2004), leverage is not a perfect proxy for overhang. Further, the correlation between $OverhangW_{t,i}^{APR}$ and leverage is moderate at 44%.

increase in $Overhang_{t,i}^{APR}$ is associated with a 6.4% decrease in investment for the median firm.

3.5 Effects of shareholder bargaining power

We test our the empirical hypotheses regarding the effects of SBP on investment by estimating equation (3.15) with our proxies for shareholder power. Table 3.3 presents the regression results when we proxy for shareholder power with the expected liquidation value. As mentioned above, the expected liquidation value represents a floor for bondholder recoveries in default, as such, a larger liquidation value decreases the bargaining power of shareholders. We expect the interaction of debt overhang and liquidation value to have a negative sign.

For ease of comparison, in Model 1 we present the estimation without this proxy for shareholder power but using only the sample of firm–years where this proxy is available. Regression estimates in Model 1 show that the coefficient of $OverhangW_{t,i}^{APR}$ is negative and statistically significant ($p < 0.01$). In Model 2, the interaction of $OverhangW_{t,i}^{APR}$ and expected liquidation value is negative and statistically significant ($p < 0.01$), indicating that the underinvestment problem is stronger for firms with large liquidation value. In terms of economic significance, for the median firm in our sample at the first quartile of expected liquidation value (high shareholder power), a one standard deviation increase in debt overhang reduces investment by 6.7%, while for a firm at the third quartile of liquidation value (low shareholder power) the underinvestment is 8.1%.

Regression estimates for the proxies of shareholder power based on institutional holdings and investors are presented in Table 3.4. In Model 1 we again show that the underinvestment effect of debt overhang is robust in the smaller sample where

Table 3.2: Descriptive statistics

This table presents descriptive statistics for the variables used in investment regressions. Variable definitions are provided in the appendix. The sample covers the period 1970–2010. Accounting variables are winsorized at the 1^{st} and 99^{th} percentile, Tobin's q is capped at 10. Panel B presents Pearson product–moment pairwise correlations between investment and different proxies for debt overhang.

PANEL A: Summary Statistics

	Mean	Std. Dev.	Median	25^{th}	75^{th}	Observations
Investment	0.139	0.128	0.105	0.059	0.178	76,841
Tobin's q	1.473	0.971	1.180	0.924	1.663	76,841
Log of assets	5.800	1.740	5.640	4.517	6.958	76,841
Cash flow	0.198	0.324	0.170	0.088	0.294	76,841
Liquidation value	0.996	0.998	0.763	0.523	1.146	76,075
Institutional holdings	0.395	0.270	0.369	0.155	0.612	54,667
Unrated dummy	0.714	0.452	1.000	0.000	1.000	48,275
Depreciation rate	0.090	0.054	0.075	0.060	0.102	70,004
$OverhangW_{t,i}^{hlw}$	0.025	0.039	0.008	0.002	0.031	55,917
$OverhangW_{t,i}^{Hazard}$	0.011	0.088	0.001	0.000	0.005	76,841
$OverhangW_{t,i}^{APR}$	0.018	0.053	0.003	0.001	0.011	76,841

PANEL B: Correlation Matrix.

	Investment	$OverhangW_{t,i}^{hlw}$	$OverhangW_{t,i}^{Hazard}$	$OverhangW_{t,i}^{APR}$
Investment	1.00			
$OverhangW_{t,i}^{hlw}$	-0.05	1.00		
$OverhangW_{t,i}^{Hazard}$	-0.03	0.30	1.00	
$OverhangW_{t,i}^{APR}$	-0.07	0.57	0.52	1.00

Table 3.3: Debt overhang and shareholder power: liquidation value

This table presents the regression results analyzing the joint impact of debt overhang and shareholder power on investment. Estimates are from the investment regression $\frac{I_{t+1,i}}{K_{t,i}} = \eta_{t+1} + \alpha_i + \beta_1 Q_{t,i} + \beta_2 \frac{CF_{t+1,i}}{K_{t,i}} + \beta_3 \frac{R_{t,i}}{K_{t,i}} + \beta_4 SBP_{t,i} + \beta_5 \frac{R_{t,i}}{K_{t,i}} \times SBP_{t,i} + \varepsilon_{t+1,i}$, where $I_{t+1,i}$ is investment, $Q_{t,i}$ is Tobin's q, $CF_{t+1,i}$ is firm cash flow, $K_{t,i}$ is the capital stock, $R_{t,i}/K_{t,i}$ is debt overhang, and $SBP_{t,i}$ is a proxy variable for shareholder bargaining power. In this table, our proxy for shareholder power is the the ratio of estimated liquidation value to the capital stock. Heteroskedasticity robust t-statistics clustered at the firm level are in parentheses. The superscripts ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	Model 1		Model 2	
	Estimate	t-value	Estimate	t-value
$OverhangW_{t,i}^{APR}$	-0.134***	(-9.334)	-0.111***	(-5.012)
$OverhangW_{t,i}^{APR} \times$ Liquidation value			-0.043***	(-3.683)
Tobin's q	0.033***	(27.454)	0.033***	(27.320)
Cash flow	0.097***	(29.405)	0.083***	(26.233)
Liquidation value			0.035***	(7.081)
Year FE	Yes		Yes	
Firm FE	Yes		Yes	
R^2	0.18		0.20	
Observations	76,075		76,075	
Years	1970-2010		1970-2010	

we can compute ownership concentration measures.

In Model 2 we proxy for SBP with the percentage of outstanding shares held by institutional investors. We expect the interaction of this variable with debt overhang to be positive since we interpret a higher institutional ownership as high shareholder power. The coefficient for the debt overhang correction remains negative and statistically significant and, as predicted, its interaction with institutional holdings is positive and statistically significant. Point estimates indicate that a one standard deviation increase in debt overhang for the median firm in our sample at the first quartile of institutional ownership (low shareholder power) reduces investment by

7.9%, while for a firm at the third quartile (high shareholder power) the reduction in investment is only 1.9%.

In Model 3, we employ the number of institutional investors as proxy for bargaining power. This variable is normalized by the total institutional dollar holdings in the firm and indicates the participation of institutional investors per million dollars of institutional holdings. We interpret higher values of this variable as decreasing shareholder power, since coordination costs among institutional shareholders increase. In this model, we include institutional holdings as an additional independent variable in order to control for institutional ownership and focus our inference in the number of institutions. Results show the interaction of debt overhang with the number of institutional investors is negative, as expected, and statistically significant at the 1% level. The economic significance of these point estimates indicate that for a median firm at the first quartile of institutional investors (high shareholder power) a one standard deviation increase in debt overhang reduces investment by 2.2%, while for a firm at the third quartile (low shareholder power) investment decreases 4.4%.

In Table 3.5 we proxy for shareholder power by the log of number of bond issues outstanding normalized by firm leverage and an indicator dummy for lack of a bond rating. In Model 2, we interact $OverhangW_{t,i}^{APR}$ with the normalized number of bond issues. Davydenko and Strebulaev (2007) interpret a larger number of bond issues as creating potential coordination costs for bondholders, in our model this results in better negotiating position for shareholders. Thus, we expect the interaction of debt overhang and bond issues to have a positive sign. We observe that this is the case as the coefficient is positive and statistically significant at the 5% level, despite the much smaller sample size. Point estimates indicate that a one standard deviation increase in debt overhang for the median firm in our sample at the first quartile of the number of bond issues (low shareholder power) reduces investment by 5.2%, while

Table 3.4: Debt overhang and shareholder power: holdings of institutions

This table presents the regression results analyzing the joint impact of debt overhang and shareholder power on investment. Estimates are from the investment regression $\frac{I_{t+1,i}}{K_{t,i}} = \eta_{t+1} + \alpha_i + \beta_1 Q_{t,i} + \beta_2 \frac{CF_{t+1,i}}{K_{t,i}} + \beta_3 \frac{R_{t,i}}{K_{t,i}} + \beta_4 SBP_{t,i} + \beta_5 \frac{R_{t,i}}{K_{t,i}} \times SBP_{t,i} + \varepsilon_{t+1,i}$, where $I_{t+1,i}$ is investment, $Q_{t,i}$ is Tobin's q, $CF_{t+1,i}$ is firm cash flow, $K_{t,i}$ is the capital stock, $R_{t,i}/K_{t,i}$ is debt overhang, and $SBP_{t,i}$ is a proxy variable for shareholder bargaining power. In this table our proxy variables for shareholder bargaining power are the start–of–period holdings of institutional investors as % of total outstanding shares and the number of institutional investors per dollar of institutional holdings. Heteroskedasticity robust t-statistics clustered at the firm level are in parentheses. The superscripts ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	Model 1		Model 2		Model 3	
	Estimate	t-value	Estimate	t-value	Estimate	t-value
$OverhangW_{t,i}^{APR}$	-0.123***	(-7.304)	-0.197***	(-8.833)	-0.077***	(-4.147)
$OverhangW_{t,i}^{APR} \times$ Inst. Holdings			0.261***	(4.690)		
$OverhangW_{t,i}^{APR} \times$ # of Inst. Investors					-0.022***	(-2.582)
Tobin's q	0.034***	(25.898)	0.033***	(25.356)	0.030***	(21.771)
Cash flow	0.079***	(23.404)	0.078***	(23.436)	0.077***	(23.386)
Institutional Holdings			0.036***	(6.061)	0.005	(0.728)
# of Institutional Investors					-0.011***	(-8.712)
Year FE	Yes		Yes		Yes	
Firm FE	Yes		Yes		Yes	
R^2	0.19		0.20		0.20	
Observations	54,667		54,667		54,667	
Years	1979-2010		1979-2010		1979-2010	

for a firm at the third quartile (high shareholder power) the reduction in investment is 1.3%.

In Model 4, we proxy for low shareholder power by an indicator for lack of a public bond rating. The data item for public bond rating in Compustat is populated starting in 1985, thus we restrict our analysis to this part of our sample. We interpret a lack of bond rating as implying that most of a firm's debt is bank debt, and, following Bris and Welch (2005), we assume bank debt is highly concentrated. Consequently, we expect the interaction of the unrated dummy and debt overhang to be negative.

The point estimate for the interaction of debt overhang and the unrated dummy is negative and statistically significant at the 5% level, indicating that firms that lack a public bond rating reduce their investment rate further as a response to the debt overhang problem. The point estimates suggest that for the median firm in our sample without a bond rating a one standard deviation increase in debt overhang reduces investment by 6.8% while firms with a bond rating reduce investment by only 3.6%.

We also consider the depreciation rate of the firm's capital stock as a variable affecting the bargaining game between shareholders and debt holders. As mentioned in Corollary 2, our model predicts shareholder power increases in the depreciation rate. We compute the average depreciation rate of the start of period capital stock for the past five years for each firm–year in our sample, and interact it with $OverhangW_{t,i}^{APR}$. In Table 3.6, we observe that the interaction of debt overhang and the depreciation rate is positive and statistically significant at the 1% level. This result suggests that the depreciation rate affects the bargaining game in default by making the firm assets less productive, and hence the expected reorganized firm less valuable, the longer the default process takes. Creditors have an incentive to resolve the bankruptcy procedure sooner, and, all else equal, the bargaining position of shareholders is improved.

Table 3.5: Debt overhang and shareholder power: debt concentration

This table presents regression results analyzing the joint impact of debt overhang and shareholder power on investment. Estimates are from the investment regression $\frac{I_{t+1,i}}{K_{t,i}} = \eta_{t+1}+\alpha_i+\beta_1 Q_{t,i}+\beta_2\frac{CF_{t+1,i}}{K_{t,i}}+\beta_3\frac{R_{t,i}}{K_{t,i}}+\beta_4 SBP_{t,i}+\beta_5\frac{R_{t,i}}{K_{t,i}}\times SBP_{t,i}+\varepsilon_{t+1,i}$ where $I_{t+1,i}$ is investment, $Q_{t,i}$ is Tobin Q, $CF_{t+1,i}$ is firm cash flow, $K_{t,i}$ is the capital stock, $R_{t,i}/K_{t,i}$ is debt overhang, and $SBP_{t,i}$ is a proxy variable for shareholder bargaining power. In this table, we proxy for shareholder power by the normalized number of outstanding bond issues and an indicator for missing rating information. Due to data availability our indicator for missing rating begins in 1985. Heteroskedasticity robust t-statistics clustered at the firm level are in parentheses. The superscripts ***, **, and *, indicate significance at the 1%, 5%, and 10% level, respectively.

	Model 1		Model 2		Model 3		Model 4	
	Estimate	t-value	Estimate	t-value	Estimate	t-value	Estimate	t-value
$OverhangW_{t,i}^{APR}$	-0.113***	(-5.181)	-0.179***	(-4.039)	-0.113***	(-6.944)	-0.071**	(-2.554)
$OverhangW_{t,i}^{APR}\times$ # of Bond Issues			0.055**	(2.093)				
$OverhangW_{t,i}^{APR}\times$ Unrated							-0.064**	(-2.012)
Tobin's q	0.035***	(12.510)	0.035***	(12.378)	0.032***	(24.269)	0.032***	(24.235)
Cash flow	0.064***	(9.237)	0.065***	(9.341)	0.069***	(21.367)	0.069***	(21.419)
Normalized # of Bond Issues			0.004**	(2.185)				
Unrated Dummy							0.003	(0.867)
Year FE	Yes		Yes		Yes		Yes	
Firm FE	Yes		Yes		Yes		Yes	
R^2	0.18		0.18		0.18		0.18	
Observations	13,690		13,690		48,275		48,275	
Years	1970-2010		1970-2010		1985-2010		1985-2010	

The economic significance of the point estimates indicate that for a median firm at the first quartile of depreciation rate a one standard deviation increase in debt overhang reduces investment by 8.9%, while for a firm at the third quartile investment decreases 7.8%.

Table 3.6: Debt overhang and shareholder power: depreciation rate

This table presents regression results analyzing the joint impact of debt overhang and shareholder power on investment. Estimates are from the investment regression $\frac{I_{t+1,i}}{K_{t,i}} = \eta_t + \alpha_i + \beta_1 Q_{t,i} + \beta_2 \frac{CF_{t+1,i}}{K_{t,i}} + \beta_3 \frac{R_{t,i}}{K_{t,i}} + \beta_4 SBP_{t,i} + \beta_5 \frac{R_{t,i}}{K_{t,i}} \times SBP_{t,i} + \varepsilon_{t+1,i}$, where $I_{t+1,i}$ is investment, $Q_{t,i}$ is Tobin's q, $CF_{t+1,i}$ is firm cash flow, $K_{t,i}$ is the capital stock, $R_{t,i}/K_{t,i}$ is debt overhang, and $SBP_{t,i}$ is a proxy variable for shareholder bargaining power. In this table, our proxy for shareholder power is the average depreciation rate of the capital stock for the past five years. Heteroskedasticity robust t-statistics clustered at the firm level are in parentheses. The superscripts ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	Model 1		Model 2	
	Estimate	t-value	Estimate	t-value
$OverhangW^{APR}_{t,i}$	-0.125***	(-7.854)	-0.206***	(-8.086)
$OverhangW^{APR}_{t,i}\times$ Depreciation			0.505***	(2.955)
Tobin's q	0.032***	(25.439)	0.032***	(25.596)
Cash flow	0.094***	(26.872)	0.091***	(26.915)
Depreciation Rate			0.283***	(7.895)
Year FE	Yes		Yes	
Firm FE	Yes		Yes	
R^2	0.18		0.18	
Observations	70,004		70,004	
Years	1970-2010		1970-2010	

3.6 Quasi–natural experiment with bankruptcy laws

In order to make a stronger case for a causality argument for the joint impact of debt overhang and shareholder power on investment we investigate a quasi–

natural experiment where one variable is affected but the other one is not. The Bankruptcy Reform Act (BRA) of 1978 and the Bankruptcy Abuse Prevention and Consumer Protection Act (BAPCPA) of 2005 provide such an opportunity. Changes to bankruptcy laws affect the bargaining power between debtors and creditors, affecting each agent's expected recovery upon default, but should have no direct impact on investment rates since the investment opportunity set remains unchanged.

The BRA, enacted into law in 1979, replaced the Chandler Act of 1938 and is generally considered as debtor friendly (White (1983)). Some of the main features the BRA codified into law included the possibility of strategic default. Before the BRA, law required a firm to be insolvent in order to file for bankruptcy protection, while after the BRA a firm no longer needed to be insolvent to file for protection (Bradley and Rosenzweig (1992)). Another novelty of the BRA included the "cram down" reorganization, where if shareholders and debt holders could not agree on a reorganization plan a court-ordered plan could be imposed. LoPucki (1995) states that, in retrospective, the BRA gave debtors "more control than necessary or appropriate", while Acharya and Subramanian (2009) argue the BRA made the US bankruptcy code more debtor friendly relative to other advanced economies at the moment.

The BAPCPA of 2005 did not represent such a major overhaul of the corporate bankruptcy code as did the BRA; nevertheless, as Hotchkiss, John, Mooradian, and Thorburn (2008) mention, the amendments to the bankruptcy code enacted in 2005 increased creditor power under Chapter 11 bankruptcy. One of the main changes made by the BAPCPA was to limit the exclusivity period under which the debtor can propose a reorganization plan to a maximum of 18 months. Under the BRA this exclusivity period lasted the first 120 days after filing for bankruptcy but it could be extended indefinitely.

These exogenous changes in bankruptcy laws are useful for our case since the effect of debt overhang is mitigated when shareholder power increases in default, and these changes in law directly impacted shareholder power. If the documented effect of debt overhang on investment is causal, then the negative impact of debt overhang should weaken after the bankruptcy change in 1979, when SBP increased, and it should increase after the 2005 reform, when creditor bargaining power was enhanced.

We test this in Table 3.7. For each reform to the bankruptcy code we include the cross section of firms one year before and one year after the change in law, and estimate on this sample our investment regression allowing for a change in the coefficient of debt overhang after the reform. Estimation results are consistent with a causal interpretation of the joint impact of debt overhang and shareholder power on investment. The impact of the debt overhang correction on investment is mitigated after the BRA, consistent with increased shareholder bargaining power. On the other hand, the effect of $OverhangW_{t,i}^{APR}$ on investment increased after the BAPCPA, in line with the argument that the reform of 2005 reduced shareholder power. These results agree with the international evidence presented in Favara, Morellec, Schroth, and Valta (2014) who show that firms underinvest less in countries where the bankruptcy code favors renegotiation.

3.7 Robustness of investment effects

In this section, we address several possible sources of bias in our results regarding the effects of SBP on investment. We use alternative models in our estimates of default probabilities and also study the potential effects of risk premia. In addition, we address the possibility of measurement errors in our proxy for average Q; the lack

Table 3.7: Changes in bankruptcy code

In this table we analyze the impact of debt overhang on investment around two changes to bankruptcy law, the Bankruptcy Reform Act of 1978 (enacted in 1979) and the Bankruptcy Abuse Prevention and Consumer Protection Act of 2005. For each event, we analyze the cross section of firms one year before and one year after the change. Estimates are from the investment regression $\frac{I_{t+1,i}}{K_{t,i}} = \alpha_i + \beta_1 Q_{t,i} + \beta_2 \frac{CF_{t+1,i}}{K_{t,i}} + \beta_3 \frac{R_{t,i}}{K_{t,i}} + \beta_4 After + \beta_5 After \times \frac{R_{t,i}}{K_{t,i}} + \varepsilon_{t+1,i}$ where $I_{t+1,i}$ is investment, $Q_{t,i}$ is Tobin's q, $CF_{t+1,i}$ is firm cash flow, $K_{t,i}$ is the capital stock, $R_{t,i}/K_{t,i}$ is $OverhangW_{t,i}^{APR}$, and *After* is an indicator variable that takes the value of 1 the year after the change in law. Heteroskedasticity robust t statistics are in parentheses. Superscripts ***, **, and *, indicate significance at the 1%, 5%, and 10% level, respectively.

	Law Change in 1979		Law Change in 2005	
	Estimate	t-value	Estimate	t-value
$OverhangW_{t,i}^{APR}$	-1.412***	(-3.326)	0.018	(0.288)
$OverhangW_{t,i}^{APR} \times$ After	0.402***	(2.701)	-0.153**	(-2.017)
After	-0.002	(-0.413)	0.011***	(3.897)
Tobin's q	0.084***	(6.041)	0.022***	(5.217)
Cash Flow	0.281***	(7.399)	0.012	(1.048)
Firm FE	Yes		Yes	
R^2	0.16		0.06	
Observations	4,267		3,682	
Years	1978, 1980		2004, 2006	

of valuable investment opportunities; and possible biases in the default forecast used to construct debt overhang. We show that our results are robust to these concerns.

3.7.1 Alternative estimates of default probability

A key improvement in our proxy for debt overhang is a more accurate default probability estimate based on a hazard model. In this section we investigate how robust are our results to different estimates of default.

We first construct a new default probability estimate using Merton's (1974) bond pricing model as shown in Bharath and Shumway (2008). This default estimate, also called the expected default frequency, is widely used among practitioners. In Table 3.8 we repeat all of our analyses except that we estimate our default overhang correction proxy with the expected default frequency from Merton's (1974) model. We refer to this proxy for debt overhang as $OverhangW^{edf}_{t,i}$.

Model 1 estimates the impact of debt overhang on investment, while Models 2 to 7 interact $OverhangW^{edf}_{t,i}$ with our proxies for shareholder bargaining power. Results are qualitatively similar to our previous findings. Debt overhang has a negative impact on investment and its interaction with our SBP proxies have all the correct sign. Statistical significance remains strong for four of our proxies while it diminished for two.

Almeida and Philippon (2007) raise the issue that financial distress is more likely to occur during bad times and risk averse investors are particularly sensitive to this. The authors argue that accounting for risk premia is important when computing estimates of financial distress. Our default probabilities estimated from the hazard model represent real–world probabilities, and as such may not properly account for this risk premia.

We address this concern in two ways. First, we use credit default swap (CDS) prices to obtain an estimate of the risk–neutral default intensity, and then use this as our default probability in equation (3.17). We follow the methodology presented in Veronesi and Zingales (2010) to back out the default intensity from observed CDS prices; however, given data restrictions we can only compute this probability starting in 2004 and only for firms with publicly traded bonds, hence our sample is substantially reduced. We call this debt overhang measure obtained from CDS default probabilities as $OverhangW^{cds}_{t,i}$, estimation results are presented in Table 3.9.

Table 3.8: Robustness, Merton's (1974) default probabilities

In this table we analyze the robustenss of our results when computing debt overhang with a different default probability estimate. The variable $OverhangW^{edf}_{t,i}$ computes debt overhang as equation (3.17) except that the default probability is estimated from Merton's (1974) model. In Model 1 we analyze the impact of debt overhang on investment, in Models 2 to 7 we analyze the joint impact of debt overhang and shareholder power on investment. Estimates are from the investment regression $\frac{I_{t+1,i}}{K_{t,i}} = \eta_{t+1} + \alpha_i + \beta_1 Q_{t,i} + \beta_2 \frac{CF_{t+1,i}}{K_{t,i}} + \beta_3 \frac{R_{t,i}}{K_{t,i}} + \beta_4 SBP_{t,i} + \beta_5 \frac{R_{t,i}}{K_{t,i}} \times SBP_{t,i} + \varepsilon_{t+1,i}$ where $I_{t+1,i}$ is investment, $Q_{t,i}$ is Tobin's q, $CF_{t+1,i}$ is firm cash flow, $K_{t,i}$ is the capital stock, $R_{t,i}/K_{t,i}$ is $OverhangW^{edf}_{t,i}$, and $SBP_{t,i}$ is a proxy variable for shareholder bargaining power. For brevity, we omit the point estimates from the the shareholder power variables by themselves. Variable definitions are provided in the appendix. Heteroskedasticity robust t-statistics clustered at the firm level are in parentheses. The superscripts ***, **, and *, indicate significance at the 1%, 5%, and 10% level, respectively.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
$OverhangW^{edf}_{t,i}$	-0.091***	-0.094***	-0.120***	-0.073***	-0.099***	-0.060***	-0.091***
	(-22.529)	(-11.996)	(-15.115)	(-13.750)	(-5.972)	(-7.493)	(-10.591)
$OverhangW^{edf}_{t,i} \times$ Liquidation value		0.001					
		(0.119)					
$OverhangW^{edf}_{t,i} \times$ Inst. Holdings			0.107***				
			(6.132)				
$OverhangW^{edf}_{t,i} \times$ # of Inst. Investors				-0.007**			
				(-2.397)			
$OverhangW^{edf}_{t,i} \times$ # of Bond Issues					0.022***		
					(2.965)		
$OverhangW^{edf}_{t,i} \times$ Unrated						-0.037***	
						(-3.681)	
$OverhangW^{edf}_{t,i} \times$ Depreciation							0.012
							(0.129)
Tobin's q	0.032***	0.032***	0.032***	0.030***	0.033***	0.031***	0.031***
	(26.515)	(26.363)	(24.432)	(21.474)	(11.666)	(23.223)	(24.665)
Cash Flow	0.100***	0.088***	0.081***	0.081***	0.070***	0.071***	0.094***
	(29.443)	(23.792)	(23.488)	(23.407)	(8.761)	(21.378)	(26.816)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.19	0.20	0.20	0.20	0.19	0.19	0.19
Observations	73,743	73,041	53,033	53,033	13,064	46,582	67,456
Years	1970-2010	1970-2010	1979-2010	1979-2010	1970-2010	1985-2010	1970-2010

The impact of debt overhang on investment remains negative and statistically significant. Moreover, despite the constrained sample size four of our shareholder power proxies are statistically significant with the correct sign, while one is insignificant.

A second way we address the issue of risk premia is by adjusting the default probabilities from our hazard model by using the risk–adjustment ratios presented in Table 3 of Almeida and Philippon (2007). Since these adjustment ratios differ by credit rating, we risk–adjust the default probability for every firm–year in our sample based on the firm's rating, and for firm–years missing a credit rating we use the predicted rating from Blume, Lim, and MacKinlay (1998). In unreported results available upon request, we repeat our main analyses with this risk–adjusted default probability. Results remain broadly consistent with our hypothesis. All point estimates have the correct sign, and four of our SBP proxies are statistically significant at the 5% level. The impact on investment of the debt overhang correction is negative but the impact is mitigated for firms with high shareholder power.

3.7.2 Measurement errors in Q

Marginal q represents the return to unobservable investment opportunities, and proxies for this unobservable term likely contain measurement error. Erickson and Whited (2000) argue that common proxies for marginal q, such as the market-to-book ratio, contain an important amount of measurement errors.

We address this measurement error problem in two ways. First, we reestimate equation (3.15) using a different proxy for average Q; then, we use the high–order generalized method of moments (GMM) estimator, as suggested by Erickson and Whited (2012).

Early studies of investment decision, such as Fazzari, Hubbard, and Peterson

Table 3.9: Robustness, estimation with CDS extracted default probabilities

In this table we estimate our debt overhang measure with implied default probablities extracted from Credit Default Swap (CDS) prices. The variable $OverhangW_{t,i}^{cds}$ computes debt overhang as equation (3.17) except that the default probability is extracted from CDS prices. In Model 1 we analyze the impact of debt overhang on investment, in Models 2 to 6 we analyze the joint impact of debt overhang and shareholder power on investment. Estimates are from the investment regression $\frac{I_{t+1,i}}{K_{t,i}} = \eta_{t+1} + \alpha_i + \beta_1 Q_{t,i} + \beta_2 \frac{CF_{t+1,i}}{K_{t,i}} + \beta_3 \frac{R_{t,i}}{K_{t,i}} + \beta_4 SBP_{t,i} + \beta_5 \frac{R_{t,i}}{K_{t,i}} \times SBP_{t,i} + \varepsilon_{t+1,i}$ where $I_{t+1,i}$ is investment, $Q_{t,i}$ is Tobin's q, $CF_{t+1,i}$ is firm cash flow, $K_{t,i}$ is the capital stock, $R_{t,i}/K_{t,i}$ is $OverhangW_{t,i}^{cds}$, and $SBP_{t,i}$ is a proxy variable for shareholder bargaining power. For brevity, we omit the point estimates from the the shareholder power variables by themselves. Variable definitions are provided in the appendix. Heteroskedasticity robust t-statistics clustered at the firm level are in parentheses. The superscripts ***, **, and *, indicate significance at the 1%, 5%, and 10% level, respectively.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
$OverhangW_{t,i}^{cds}$	-0.105***	-0.085**	-0.356***	-0.216**	-0.006	-0.188***
	(-2.611)	(-2.010)	(-3.084)	(-2.343)	(-0.054)	(-3.629)
$OverhangW_{t,i}^{cds} \times$ Liquidation value		-0.042***				
		(-3.178)				
$OverhangW_{t,i}^{cds} \times$ Inst. Holdings			0.321**			
			(2.354)			
$OverhangW_{t,i}^{cds} \times$ # of Inst. Investors				-0.061*		
				(-1.755)		
$OverhangW_{t,i}^{cds} \times$ # of Bond Issues					-0.039	
					(-1.246)	
$OverhangW_{t,i}^{cds} \times$ Depreciation						0.827**
						(2.278)
Tobin's q	0.031***	0.032***	0.031***	0.030***	0.031***	0.029***
	(5.339)	(5.811)	(5.361)	(5.284)	(5.107)	(5.624)
Cash Flow	0.014	-0.004	0.008	0.011	0.008	0.020
	(0.798)	(-0.258)	(0.499)	(0.777)	(0.395)	(1.253)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.23	0.27	0.23	0.24	0.22	0.24
Observations	1,254	1,248	1,211	1,211	1,164	1,227
Years	2004-2010	2004-2010	2004-2010	2004-2010	2004-2010	2004-2010

(1988), use a different proxy for marginal q, referred to as Macro q in Chava and Roberts (2008) or q^{FHP} in Erickson and Whited (2012). This proxy measures investment opportunities only in the capital stock, while the market-to-book ratio measures investment opportunities in total assets.

Macro q is constructed as the sum of the book value of debt plus the market value of equity minus the book value of current assets, all divided by the capital stock. Erickson and Whited (2000) argue that Macro q contains a lower error–to–signal ratio. In addition, by using Macro q we are in effect normalizing all variables by the same deflator, the capital stock. However, as Erickson and Whited (2012) note, Macro q has two undesirable features. It does not account for intangible assets and, more importantly, it is not bounded to be positive. In our sample, we find some firm–years with a negative value of Macro q —obviously inconsistent with the unobservable marginal q. For this reason we prefer to use the market-to-book ratio as our primary measure of Q and present Macro q as a robustness check.

We reestimate our regressions using Macro q and find qualitatively similar results. We find the coefficient for Macro q is highly significant, with a positive sign and magnitude similar to those in previous studies, and the coefficient for $OverhangW_{t,i}^{APR}$ barely changes. When we study the joint impact of debt overhang and shareholder power on investment we find that shareholder power mitigates the underinvestment effect of debt overhang. Point estimates all have the correct sign, and four of our proxies are statistically significant.

Recent literature in investment regressions has proposed not only different proxies for investment opportunities, but also different estimators that can better handle measurement error, such as the high–order GMM estimator of Erickson and Whited (2000, 2002). This estimator is robust to measurement error but requires Tobin's q to have non-normal skewness and kurtosis to be identified. We choose the estimator based on conditions of order five (GMM5) since Monte Carlo evidence in Erickson and Whited (2012) shows this estimator is more robust to model mis-specification.

The Erickson and Whited (2000, 2002) estimator is not a panel but, rather, a cross sectional estimator. Thus, we first carry out a within transformation in our variables to account for firm and years effects. We then compute the GMM5 estimates for each fiscal year and present the minimum distance estimates, as recommended by Erickson and Whited (2012)l. We employ a grid of starting values to ensure that our results represent a global minimum to the GMM objective function.

Table 3.10 presents regression estimates. Our results are consistent with those of Erickson and Whited (2012). We observe a higher R^2 while the coefficient for Tobin's q increases, and we still find a significant cash flow coefficient, though the point estimate is smaller.

In Model 1 we estimate our baseline investment regression and find the coefficient for our proxy of debt overhang is negative and statistically significant ($p < 0.01$). In Models 2 through 7 we estimate our regressions with the interaction of $OverhangW_{t,i}^{APR}$ and shareholder power. The results are broadly consistent with our hypothesis that shareholder power mitigates the impact of debt overhang on investment. All interaction coefficients have the correct signs and four of our proxies are statistically significant at the 1% level. It is not unexpected that some proxies lose statistical significance since, as mentioned in Erickson and Whited (2012), the high-order estimator requires more observations to achieve consistent estimates.

In untabulated analysis available upon request, we obtain qualitatively similar results when using the instrumental variables estimator proposed by Almeida, Campello, and Galvao (2010) and Biorn (2000). In addition, we follow the suggestions of Roberts and Whited (2010) and estimate our least squares regressions without firm fixed effects and find our main results are unchanged.

Table 3.10: Robustness, measurement error consistent estimation

In this table we analyze the robustness of our results to measurement errors in our proxy for Q by using the high-order GMM estimator from Erickson and Whited (2000, 2002, 2012). We present the minimum distance estimates from the GMM5 estimator as proposed by Erickson and Whited (2012). In Model 1 we analyze the impact of debt overhang on investment, in Models 2 to 7 we analyze the joint impact of debt overhang and shareholder power on investment. Estimates are from the investment regression $\frac{I_{t+1,i}}{K_{t,i}} = \eta_{t+1} + \alpha_i + \beta_1 Q_{t,i} + \beta_2 \frac{CF_{t+1,i}}{K_{t,i}} + \beta_3 \frac{R_{t,i}}{K_{t,i}} + \beta_4 SBP_{i,t} + \beta_5 \frac{R_{t,i}}{K_{t,i}} \times SBP_{t,i} + \varepsilon_{t+1,i}$ where $I_{t+1,i}$ is investment, $Q_{t,i}$ is Tobin's q, $CF_{t+1,i}$ is firm cash flow, $K_{t,i}$ is the capital stock, $R_{t,i}/K_{t,i}$ is $OverhangW_{t,i}^{APR}$, and $SBP_{i,t}$ is a proxy variable for shareholder bargaining power. For brevity, we omit the point estimates from the shareholder power variables by themselves. Variable definitions are presented in the appendix. The t-statistics are in parentheses. ***, **, or * indicates that the coefficient estimate is significant at the 1%, 5%, or 10% level, respectively.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
$OverhangW_{t,i}^{APR}$	-0.079***	-0.075***	-0.211***	-0.102***	-0.169***	-0.025	-0.169***
	(-5.801)	(-4.707)	(-9.541)	(-6.678)	(-3.970)	(-1.362)	(-6.947)
$OverhangW_{t,i}^{APR} \times$ Liquidation value		-0.030***					
		(-5.449)					
$OverhangW_{t,i}^{APR} \times$ Inst. Holdings			0.260***				
			(4.844)				
$OverhangW_{t,i}^{APR} \times$ # of Inst. Investors				-0.048***			
				(-5.499)			
$OverhangW_{t,i}^{APR} \times$ # of Bond Issues					0.032		
					(1.265)		
$OverhangW_{t,i}^{APR} \times$ Unrated						-0.012	
						(-0.435)	
$OverhangW_{t,i}^{APR} \times$ Depreciation							0.469***
							(3.115)
Tobin's q	0.078***	0.075***	0.078***	0.063***	0.068***	0.072***	0.067***
	(37.250)	(34.833)	(36.704)	(6298754.127)	(26.956)	(36.619)	(40.644)
Cash Flow	0.033***	0.019***	0.019***	0.020***	0.035***	0.020***	0.041***
	(8.824)	(4.922)	(5.101)	(5.561)	(5.663)	(5.300)	(10.903)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.222	0.254	0.243	0.229	0.244	0.236	0.211 1
Observations	76,841	76,075	54,667	54,667	13,690	48,275	70,004
Years	1970-2010	1970-2010	1979-2010	1979-2010	1970-2010	1985-2010	1970-2010

3.7.3 Lack of investment opportunities

Another source of concern for our results is the possibility that the lack of growth opportunities for some firms in our sample drives our observed results. Lang, Ofek, and Stulz (1996) show that leverage and investment have a negative correlation in firms with low growth opportunities, but not in firms with high growth options. If our proxies for shareholders power are concentrated mainly in firms with high investment opportunities and our control for this variable (Tobin's q) is noisy, then our previous results could be an artifice of growth options.

We analyze this possibility by estimating our investment regression on two subsample of firm–years, those with Tobin's q value below the sample median and those above it. Though Tobin's q may suffer from measurement errors, unless these errors are substantial, firm–years with value of Tobin's q less than the median represent on average firms without valuable investment opportunities, while the group of firms above the median represent on average those with profitable growth options. For the sake of brevity, we present results for only two of our shareholder power proxies, institutional holdings and the number of institutional investors, since these proxies may differ more strongly by growth opportunities, but we stress that results are qualitatively similar for our other proxies.

Our estimation results are presented in Table 3.11. We observe that the point estimates for our debt overhang correction are negative and statistically significant at the 1% level for both groups of firms, in fact, the point estimates are larger for the group of firm–years with Tobin's q above the median. This suggest that the impact of debt overhang on investment is not caused by lower investment opportunities. In addition, the interaction of debt overhang with our shareholder power proxies has the correct sign and is statistically significant in both subsamples with roughly similar point estimates across them.

In unreported results we also include an industry fixed effect at the two digit SIC level to control for time invariant omitted variables that can potentially create an endogenous feedback between investment and debt overhang. Our results are unchanged by the inclusion of industry dummies.

3.7.4 Additional tests

We conduct additional robustness checks on our results which we discuss here but, in the interest of space, do not present in table format. For our main analyses we computed debt overhang with equation (3.17) assuming that the default hazard for each of the next 20 years is the same as the default hazard for next year; in other words, the term structure of default is flat. Moreover, our default forecast is based on the full sample estimates from Table 3.1, which could result in look–ahead bias. We test if either of those two sources of error in the default forecast bias our results.

We first investigate the flat term structure of default hazard by instead matching the average term structure from Moody's historical probabilities. For every firm–year in our sample, we estimate our hazard model for default for the next fiscal year and, when computing debt overhang by equation (3.17), for every period $t+s$ we multiply this default hazard by a factor so that its term structure of default matches that from Moody's historical data. This new estimate of debt overhang has embedded within it a term structure that matches, on average, that observed in Moody's empirical distribution of default.

To account for the effect of look–ahead bias in the estimation of default, we reestimate our default hazard model with an expanding sample. Our bankruptcy database starts in 1962. We allow for 10 years to start our estimation of the hazard

Table 3.11: Robustness, high and low investment opportunities

In this table we analyze the joint impact of debt overhang and shareholder power on investment for a subsample of firm–years segmented by their value of Tobin's q. Estimates are from the investment regression $\frac{I_{t+1,i}}{K_{t,i}} = \eta_{t+1} + \alpha_i + \beta_1 Q_{t,i} + \beta_2 \frac{CF_{t+1,i}}{K_{t,i}} + \beta_3 \frac{R_{t,i}}{K_{t,i}} + \beta_4 SBP_{t,i} + \beta_5 \frac{R_{t,i}}{K_{t,i}} \times SBP_{t,i} + \varepsilon_{t+1,i}$ where $I_{t+1,i}$ is investment, $Q_{t,i}$ is Tobin's q, $CF_{t+1,i}$ is firm cash flow, $K_{t,i}$ is the capital stock, $R_{t,i}/K_{t,i}$ is $OverhangW^{APR}_{t,i}$, and $SBP_{t,i}$ is a proxy variable for shareholder bargaining power. In this table our proxy variables for shareholder bargaining power are the start–of–period holdings of institutional investors as % of total outstanding shares and the number of institutional investors per dollar of institutional holdings. For brevity, we omit the point estimates from the the shareholder power variables by themselves. Heteroskedasticity robust t-statistics clustered at the firm level are in parentheses. The superscripts ***, **, and *, indicate significance at the 1%, 5%, and 10% level, respectively.

	Tobin's q below median			Tobin's q above median		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
$OverhangW^{APR}_{t,i}$	-0.099***	-0.183***	-0.042	-0.174***	-0.225***	-0.135***
	(-5.209)	(-6.154)	(-1.545)	(-8.183)	(-6.782)	(-5.675)
$OverhangW^{APR}_{t,i}\times$ Inst. Holdings		0.301***			0.223***	
		(3.245)			(3.099)	
$OverhangW^{APR}_{t,i}\times$ # of Inst. Investors			-0.037***			-0.028**
			(-2.922)			(-2.447)
Tobin's q	0.101***	0.098***	0.087***	0.027***	0.027***	0.026***
	(19.480)	(15.531)	(12.895)	(22.133)	(20.389)	(17.972)
Cash Flow	0.092***	0.062***	0.062***	0.091***	0.079***	0.079***
	(17.492)	(11.603)	(11.605)	(21.427)	(18.241)	(18.321)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.11	0.11	0.11	0.21	0.21	0.21
Observations	38,420	22,874	22,874	38,421	31,793	31,793
Years	1970-2010	1979-2010	1979-2010	1970-2010	1979-2010	1979-2010

model of default and make an out-of-sample forecast for the next year's default hazard. We recompute our debt overhang proxy beginning in 1973, and for every year t in the sample the default probability used in equation (3.17) is the out-of-sample forecast using only information up to year *t-1*.

We reestimate our regression analyses with these corrected measure of debt overhang and find qualitatively similar results as before, all of our SBP interactions have the correct sign and maintain statistical significance of at least the 5% level.

3.8 Discussion

The dampening effects of debt overhang on capital investment are of substantial economic interest and attract much attention from academic financial economists, policy makers, and the press. However, the available theoretical and empirical studies on this topic typically assume that equity holders truncate their investment horizon at default. But, in practice, shareholders have significant bargaining power during financial distress and bankruptcy and several empirical studies document substantial deviations from the absolute priority rule (APR) in favor of shareholders. Out of court debt restructurings, debt–equity exchanges, and APR violations in formal bankruptcies allow for shareholder recovery in default. If shareholders expect to recover some portion of firm value during the post-default firm reorganization, then the underinvestment consequences of debt overhang may be significantly mitigated.

We theoretically and empirically investigate the implications of shareholders' bargaining power during default on the debt overhang and its negative effect on investment. To derive testable predictions we construct a dynamic bargaining model between equity and debt holders to analyze the equilibrium firm reorganization during default. Our model identifies firm-specific characteristics that influence SBP and clarifies the relation of SBP to debt overhang and investment. In particular, the equilibrium expected debt recovery by creditors (or equity holders) depends on shareholder and bondholder ownership concentration; the expected liquidation value; and, the rate of capital depreciation.

To test the empirical predictions of the model, we compute a new measure of debt overhang correction that does not infer default probabilities from credit ratings, enabling us to estimate the debt overhang correction measure for a significantly larger sample of firms. Moreover, this allows us to steer clear of the criticism of credit rating agencies and the conflicts of interest inherent to their business models, which can lead to inaccurate default probabilities implied by the credit ratings.

Consistent with the theoretical predictions, we find that the negative investment effect of the debt overhang is mitigated by higher shareholder ownership concentration and liquidation values, but exacerbated by greater bondholder ownership concentration. In addition, higher depreciation rates ceteris paribus raise investment and mitigate the underinvestment effects of debt overhang.

We show our results are robust to a variety of issues, such as different default estimates, measurement errors in the proxy for investment opportunities, and considering multi-period and out-of-sample default probabilities. The evidence presented in this essay confirms the economic importance of debt overhang on investment and demonstrates how shareholder bargaining power and the potential for shareholder recovery in financial distress can reduce the underinvestment caused by debt overhang.

4. SUMMARY

In this dissertation, we address two questions in corporate finance. First, we investigate if there is evidence of benchmarking in the compensation of top executives of firms. Second, we ask if potential shareholder bargaining power can affect the underinvestment caused by debt overhang.

In the first essay, “A New Benchmark: Relative Performance Evaluation with Total Returns”, we find strong evidence in support of RPE in the compensation of top executives. Contrary to previous literature, in our pay–performance regressions the performance part is the total return of the firm instead of just its equity return. We argue this is a sensible approach since most of the exogenous common shocks occur at the asset level. In addition, we cannot reject that the magnitude of RPE used in the average contract is optimal in the view of Holmström and Milgrom (1987). While this essay is not a formal test of efficiency in the executive labor market, we find support for one of the main implications of an efficient executive labor market, benchmarking in compensation.

In the second essay, “Shareholder Bargaining Power, Debt Overhang, and Investment”, we analyze how shareholder bargaining power affects the underinvestment problem caused by debt overhang. We find that measures correlated with weak shareholder power, such as high expected liquidation values and bondholder ownership concentration, enhance the underinvestment effect of debt overhang; while typical proxies for strong shareholder bargaining power, such as equity ownership concentration, mitigate the underinvestment. Our results highlight how shareholder bargaining power in default can affect the investment choices of firms.

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APPENDIX

TABLES

Table A-1: Variable definitions for Section 3.

Debt Overhang Correction Measures

We estimate the Hennessy, Levy, and Whited (2007) debt overhang correction for every firm i and year t as

$$Overhang^{hlw} = \frac{LTD_t}{K_t} \times \text{Recovery Rate} \times \left[\sum_{s=1}^{20} \rho_{t+s}[1 - 0.05(s-1)] \times r_{t+s}\right]$$

where LTD represents total debt (Compustat items dlc + $dltt$), K is the capital stock ($ppegt$), Recovery Rate is the rate for defaulted senior unsecured bonds by two digit SIC from Altman and Kishore (1996), and r_{t+s} is the price of a tax–exempt zero coupon bond of maturity s at time t obtained from J. Huston McCulloch's website. The probability of default, ρ_{t+s}, is Moody's hazard rate of default by bond rating for a bond s years after issuance, from Keenan, Hamilton, and Berthault (2000).
Our proposed measure of debt overhang is

$$OverhangW_{t,i}^{APR} = \frac{LTD_t}{K_t} \times (1-\gamma) \times \left[\sum_{s=1}^{20} \rho_t^{hazard}[1 - 0.05(s-1)] \times r_{t+s}\right]$$

where LTD, K, and r_{t+s}, are the same as above. Instead of using observed recovery rates we assume that APR is followed, thus the recovery is one minus a proportional distress cost γ which we set at 10%. The probability of default, ρ_t^{hazard}, is the predicted default probability from a discrete–time hazard model based on Shumway (2001) and Chava and Jarrow (2004).

Hazard Model of Default

Following Shumway (2001) and Chava and Jarrow (2004), we use the following variables in our hazard model of bankruptcy

- NI/TA: ratio of net income to total book assets (ni/at).
- TL/TA: ratio of total liabilites to total book assets ($(lct+dltt+txditc+lo)/at$).
- Relative size: log of the ratio of the firm's market capitalization to the NYSE/ AMEX/NASDAQ total capitalization in December of the previous year [CRSP items log $((prc \times shrout \times 1000)/totval)$].
- Excess return: monthly compounded return for the firm minus the return for the NYSE/AMEX/NASDAQ index for the previous calendar year ($ret - vwretd$).
- Sigma: standard deviation of residuals from a market regression of monthly stock returns for the previous calendar year.

Variables Used in the Investment Regressions

- Investment: ratio of capital expenditures minus sales of plant, property and equipment to the start-of-period capital stock ($(capxv - sppe)/ppegt$).
- Cash flow: the sum of net income plus depreciation and amortization divided by the start-of-period capital stock ($(ib + dp)/ppegt$).
- Tobin's q: the ratio of the market value of assets to total assets ($(at + csho \times prcc\_f - ceq - txdb)/at$).

- Macro q: the sum of total book debt and market equity less total inventories divided by the start-of-period capital stock ($(dltt + dlc + csho \times prcc\_f - act)/ppegt$).

Shareholder Bargaining Power Proxies

- Liquidation value: ratio of expected asset liquidation value to the capital stock, according to Berger, Ofek, and Swary (1996) ($(0.715 \times rect + 0.547 \times invt + 0.535 \times ppent)/ppegt$).

- Institutional holdings: total of all shares held by institutional investors divided by the firm's outstanding shares, from Thomson's 13f database.

- Number of institutional investors: logarithm of the number of different institutions holding equity in the firm divided by the total dollar holdings of all institutions, from Thomson's 13f.

- Number of bond issues: number of bonds outstanding divided by the leverage ratio of the firm, from Mergent's Fixed Income Securities Database.

- Depreciation rate: five year average of the ratio of depreciation expense to the capital stock ($dp/ppegt$).

- Unrated dummy: indicator dummy if firm is missing long term credit rating in Compustat ($splticrm$).